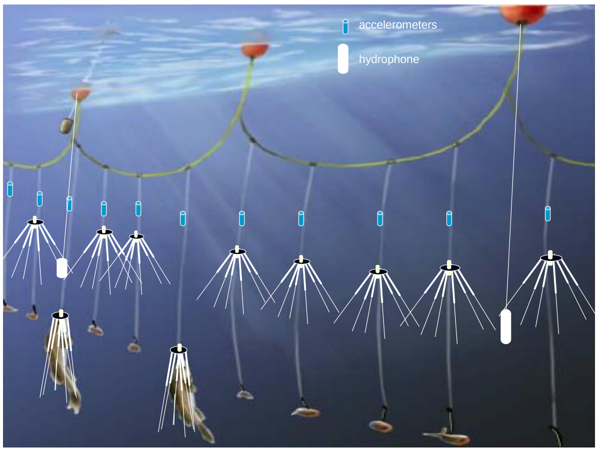
REPORT

WORKSHOP ON THE DEPREDATION IN THE TUNA LONGLINE FISHERIES IN THE INDIAN OCEAN

9 – 10 July, 2007

Training room, Seychelles Fishing Authority,
Victoria Fishing Port, Victoria, Seychelles



Organized by
Indian Ocean Tuna Commission (IOTC) and National Research Institute of Far Seas Fisheries (NRIFSF) (Japan)
in collaboration with the Seychelles Fishing Authority

Summary 3
Background 4
Election of Workshop Chair, Rapporteurs, and Panelists 4
Terminology 4
AGENDA ITEM 1 - SITUATION WITH REGARD TO DEPREDATION 4
[A1-01] Status of the IOTC databse 4
NATIONAL AND REGIONAL REPORTS 5
[A1-02] Australia 5
[A1-03] China 5
[A1-04] France (La Réunion) 5
[A1-05] India 6
[A1-06] Japan 6
[A1-07] Kenya 6
[A1-09] Seychelles 6
[A1-10] South Africa 6
[A1-11] Soviet Union 7
[A1-12] Spain (IEO: La Coruña) 7
[A1-13] Spain (IEO: Tenerife) 7
[A1-14] Sri Lanka 7
[A1-15] Atlantic and Pacific Oceans 7
[A1-16] Indian Ocean (1960s)(I) 8
[A1-17] Indian Ocean (1960s)(II) 8
[A1-18] British Indian Ocean Territory (BIOT) 8
[A1-22] China (Pacific) 8
[A1-23] Mediterranean Sea (Video) 8
AGENDA ITEM 2 - CATCH STATISTICS 9
AGENDA ITEM 3 – MITIGATION 10
[A3-01] Review of Mitigation Methods 10
[A3-02] Mitigation of toothed whale depredation on the longline fishery in the eastern Australian Fishing Zone – [McPherson] (Bach) 11
[A3-03] An option for long range acoustic detection of toothed whale depredation on longlines – [McPherson] (Bach) 12
[A3-04] Development of passive acoustic tracking systems to investigate toothed whale interactions with fishing gear ? – [McPherson] (Bach) 12
[A3-05] Device Demonstration – [Guinet] (Vely) 12
[A3-06] Learning to coexist with whales – the Chilean experience in the Patagonian toothfish fishery. [Moreno] (Gales). 12
[A3-07] On the invention of effective and perspective device (protective net) for the mitigation of depredation of fishes in longline fisheries – [Pshenichnov and Zaitsev] (Romanov)... 13
AGENDA ITEM 4– RELATIONS WITH MARINE ECOLOGY 13
[A4-01] Ecological interactions between fisheries and marine mammals in the Indian Ocean. Do whales and fisheries compete for resources? – [Gales] 14
[A4-02] Fine scale behavioral and underwater video observations of sperm whales near longline fishing vessels in the Gulf of Alaska and recommended deterrents to avoid depredation – [Janice Straley] (Gales) 14
PANEL DISCUSSIONS 14
Agenda item 1 – Situation with regard to depredation [Romonov] 14
Agenda item 2 – Improvement of catch statistics [Mcloughlin] 18
Agenda Item 3 – Mitigation [Gales] 19
Agenda Item 4 – Relation with the marine ecosystem [Masac]. 20
WORKSHOP RECOMMENDATIONS 21
Appendix 1. Agenda 22
Appendix 2. List of participants 23
Appendix 3. List of presentations 25
Appendix 4. Abstracts 27

Summary

- Depredation is the partial or complete removal of captured fish or bait from fishing gear by predators. During this workshop discussion concentrated on depredation of tuna longline fishing gear in the Indian Ocean.
- Depredation on longline gears are recorded for many marine species: fish, marine mammals, birds, crustaceans, squids, however current workshop discussed depredation by principal predators: sharks and cetaceans, The cetaceans mostly include false killer whales *Pseudorca crassidens*, and short-finned pilot whales *Globicephala macrorhynchus* but other cetacean species including killer whales *Orcinus orca* also contribute. The species composition estimates could be improved with better field guides/ training of fishers and observers.
- Data were available from several countries and reported in their National Reports.
  - The quality of the data is variable, as are the metrics used to quantify depredation. Standard terminology should be adopted to quantify depredation.
  - The identification of the species causing the depredation is largely based on the shape of the wounds. Sharp edges are usually taken to indicate sharks, ragged edges to indicate cetaceans. However, this separation may be confounded by post-depredation feeding by both cetaceans and fishes which may reshape the original wound(s). There is a need to standardize and verify the criteria used to identify the predator species.
- The magnitude of losses on sets where depredation occurs can be large, particularly where cetaceans are the major cause of the depredation.
- Catch that has suffered from depredation by sharks can often still be marketed (one country reported that damaged fish are actually in greater demand.) than catch that is landed whole. Because of these factors cetacean depredation is the more important problem.
- Those species causing depredation vary both seasonally and spatially.
- Depredation rates vary by the species being depredated.
- Species depredated vary spatially and seasonally, partly or wholly as a consequence of the availability of different species to longline gear.
- Based on the data presented, the fraction of total catch that suffers from depredation seems often to be less than 5% on average. However,
  - On those sets where depredation occurs, a large part of the catch can be lost (up to 100%), with corresponding economic loss to the fishers.
  - Predators appear to prefer targeted tuna to other species, although one study found swordfish to be the primary target species depredated.
- Both catch and depredation statistics need improvement for stock assessment purposes. Major fishing countries now treat the depredation data as confidential and have not provided them to the IOTC. It is essential that all fishing entities provide such data to the IOTC on a timely basis.
- Methods to mitigate depredation losses to cetaceans involve shifting patterns in gear deployment to disrupt learned behavior, passive acoustic detection to avoid setting near pods, active acoustics to harass approaching individuals, and physical barriers to minimize attacks on hooked fish. The quantitative benefits of these methods have yet to be demonstrated, but have shown positive results that should be further researched.

Background

At its fifth Session of the IOTC Commissioner meeting in Kyoto in 2000, it adopted Resolution 00/02 *Resolution on a survey of predation of longline caught fish*. In response to this at least seven countries undertook a program of predation surveys spanning (maximum) five years from 2000/01-2004/05. The resolution also recommended that a workshop be held after the surveys were over. The surveys were completed in 2005 and all the survey data were recovered by the end of 2006. Given this background, in its 9th Session, the IOTC Scientific Committee endorsed a two day Workshop from 9-10 July, 2007 in Seychelles, in order to discuss the results of the five year predation surveys and other relevant topics. This current workshop fulfills the IOTC Scientific Committee endorsement and was organized by the IOTC and National Research Institute of Far Seas Fisheries (NRIFSF) of Japan.

Election of Workshop Chair, Rapporteurs, and Panelists

Workshop participants approved the Conveners' nominees for these posts. Charles Anderson assumed the Workshop Chair, P. Goodyear assumed the role of Chief Rapporteur and was assisted by F. Poisson, S. Varghesee, R. Pianet, B. Baker, and S. Peterson who rapporteured different agenda items. E. Romanov, K. Mcloughlin, N. Gales, and F. Marsac accepted posts as panelists for the different agenda topics.

Terminology

The scavenging of longline catch by sharks and cetaceans has been termed both "depredation" and "predation". Workshop participants discussed the issue and selected the term "depredation" to refer to predator attacks on hooked fish, reserving the term "predation" to describe predator feeding on free swimming prey.

The following sections summarize the presentations and discussions related to the topics addressed by the Workshop. The text labels refer to the agenda items and, when available, to the corresponding abstracts in Appendix 4.

AGENDA ITEM 1 - SITUATION WITH REGARD TO DEPREDATION

[A1-01] STATUS OF THE IOTC DATABASE

The Secretariat presented a report on the status of the IOTC databases for depredation data (A1-01). Twelve countries were identified as potential contributors of data. Of these, 5 countries (UK, France, India, Mauritius, and South Africa) had already submitted data. Five other countries (Australia, China, Kenya, Ukraine, and Spain) described their data as not yet ready to be released. Japan and Taiwan declared their data to be classified confidential and appear unlikely to supply data for the IOTC database in the near future (see p.26-28, Appendix A for details).

NATIONAL AND REGIONAL REPORTS

[A1-02] Australia

Australia presented a case study based on observer information from longline vessels fishing off Australia's west coast. Observers collected data from Japanese longline vessels operating in the Australian Fishing Zone during the period 1992-1997 from Australian vessels fishing the AFZ and high seas from 1999-2006. Both programs collected accurate information such as fishing effort, target species, bycatch, and interactions with protected species. The data were collected on the condition of the catch, including damage, but the cause of damage to the catch was not explicitly recorded. Observer comments suggested that about 69% and 22% of the damage could be attributed to cetaceans and sharks, respectively. Overall, about 7.3% of the catch was damaged, but some of the damaged fish were retained for crew consumption or sale. There appeared to be no significant difference in the depredation rates observed for Australia and Japanese operators. Improved data collection would reduce uncertainty in stock assessment, and help quantify economic cost to the industry. Specifically, advice to observers to distinguish shark and cetacean depredation, logbook fields where the skipper could record lost gear and/or strategy changes to reduce the incidence of depredation events.

[A1-03] China

Monthly predation rates-loss estimated – 11.2 t. depredation 10% by sharks, remaining 90% by whales.

[A1-04] France(La Réunion)

Pelagic longlining was first introduced to fish for swordfish in off Réunion Island (France) in the Indian Ocean in the early 1990s. As the fleet and fishing grounds expanded, fishermen recorded an increase in false killer whale *Pseudorca crassidens* and short-finned pilot whale *Globicephala macrorhynchus* pillaging bait and catch, especially target species. The damage can sometimes extend to gear as well. Between 1997 and 2000, an average of 4.3% (80 t) and 3.2% (60 t) of the annual swordfish catches were damaged by cetaceans and sharks, respectively.

The effectiveness of pingers to reduce depredation and the inclination of fishers to use this device was tested during 4 domestic longline trips with a total of 23 sets with standard commercial longline gear equipped with pingers. The pingers had no discernable repellent effect on target fish, and they were not proven to protect the line against cetaceans. The fishers showed little interest in continuing to use these devices.

Pseudorca crassidens and *Globicephala macrorhynchus* responsible for depredation are not threatened by the longline fishery. During these 4 years survey, 3 juveniles have been caught purely by accident and released alive while One Risso's dolphin (*Grampus griseus*) was retrieved dead

While depredation on the fishery in this study appeared not to be a major issue, worldwide interactions between marine mammals and fisheries are a growing conservation issue. Knowledge of the behavior, biology, hearing abilities, population sizes and migration patterns of these two species needs improvement. Observations and data collection should continue. However, observer protocols need to be standardized to get a global picture of depredation and other issues in the Indian Ocean. Fishing industry, scientists, economists and decision makers must be involved in these future research plans.

[A1-05] India
The Fishery Survey of India (FSI) collected depredation data from daytime sets on three longline research survey vessels operating in the Indian EEZ from 2001-2005. Sharks appeared to be responsible for most of the depredation observed in this study. Analyses were restricted to only those sets where some of the catch suffered depredation damage. For this subset of the data the depredation rate was estimated to be about 16% by number for those sets where the damage was observed. Extrapolation of this estimate to the fishery as a whole predicted a 20% loss in landings by weight which would amount to nearly 45 thousand tonnes. This estimate is likely very high because the depredation rate was based on only sets where depredation was observed.

[A1-06] Japan
The depredation rate for the Indian Ocean was estimated based on longline sets where at least one individual was damaged. For this subset of all longline sets an average of 5.1 fish per set was attacked. The total number of depredated fish was 2270. Of these 51% were yellowfin, 26% were bigeye tuna and 12% were albacore. Sharks were estimated to be responsible for 55% of the attacks, killer and false killer whales took about 43%, and the other 2% may have been giant squids, other mammals etc. Since these estimates only considered sets where depredation had occurred, they are high when extrapolated to the fishery as a whole.

[A1-07] Kenya
Depredation in the artisanal and sport fisheries is mostly caused by sharks. The highest incidence of tuna depredation in these fisheries is in February and March which also corresponds to the highest catches of sharks. The problem is greater in the artisanal fishery than in the sport fishery. Partly eaten fish are retained for sale, and are preferred by the market. The industrial longline fishers have more problems with killer whales than sharks, and the main problem seems to be that the killer whales are systematically removing 60-70% of deployed baits, rather than attacking the catch itself.

[A1-09] Seychelles
The target species of the longline fishery of the Seychelles archipelago include tunas, but swordfish is the main target species. Depredation data for swordfish were collected from preexisting databases, logbooks and fishermen interviews and VMS. The effects of gear geometry and set location were evaluated using GLMs. Depredation was mainly by shortfin pilot whales, false killer whales and pelagic sharks. Shark depredation was negatively related to length of the line and increased from north to south. The proportion of sets with shark depredation was significantly higher than by cetaceans (41% vs. 16%). However, when depredation occurred, cetaceans took an average of 60% of the fish caught compared to 18% for sharks. The highest depredation rates occurred in areas of the highest swordfish CPUE, suggesting that both sharks and cetaceans congregate in areas of high swordfish abundance. Overall the depredation rate was 19%, one of the highest in the world. Economic loss was estimated at 340 €/1000 hooks which equates to about 1,000,000 € over the 1995-2006 period

[A1-10] South Africa
Observers aboard pelagic longline vessels targeting tuna, swordfish, and sharks off South Africa, and demersal longline vessels targeting Patagonian toothfish off the Prince Edwards Islands recorded marine mammal and depredation data. Killer whales were observed in all months from the monitored South African longline vessels, but with seasonal variations (maximum in January and minimum in April-May). The study concluded that killer whales consumed 561 fish from 116 longline sets, 83% of these were swordfish, and 10-20% depredation occurred in the depredated sets. The study only evaluated the loss from sets where marine mammals were sighted, and assumed that all depredated fish were taken by marine mammals. Some shark depredation may

also have occurred and been erroneously attributed to marine mammals. Overall, the opinion of the study authors was that the overall depredation rate was about 0.5%

[A1-11] Soviet Union

Depredation of pelagic longline catch was evaluated from long-term historical data collected during Former Soviet Union research cruises in the Indian Ocean. The observations cover the 1961-1989 period only, and may not be representative of the present situation taking consideration recent modification of fishing gears and changes in the target species and fishing tactic. Cruises where no depredation data were recorded were removed from the data set prior to analyses on the assumption that the scientific crews were not recording depredation on those cruises. This may have caused a 9-21% overestimation of the depredation indexes for 26.8% of the fraction of sets suffering depredation. GLM analyses showed a four-fold increase in the proportion of sets depredated by cetaceans with an increased soaking time of 1 hr. The proportion of the catch depredated (by number) was 6.8%, and tunas comprised 83.6% of the total number of damaged fish. Cetaceans accounted for 11.6%, sharks 43.8%, and unknown predators 44.6% of the total numbers of fish depredated. Most of the unknowns were probably also sharks. Shark damage was of less concern than that caused by cetaceans because shark damaged fish could often still be marketed. Also cetaceans tended to focus on the target species, high level of damage to individual fish, and their learning ability. Depredation rates were spatially heterogeneous being the highest in tropical areas. Shark depredation was also 4-times higher on sets deployed on sea mounts.

[A1-12] Spain (IEO : La Coruña)

Depredation of swordfish in the Spanish surface longline fishery by false killer whales (*Pseudorca crassidens*) was evaluated using 1992-2006 logbook and observer data in the Atlantic, Indian, and Pacific Oceans. Depredation was detected in 2% of the sets observed by scientists. Depredation rates were estimated to be between 0.5-2.6% of the swordfish catch in the Indian Ocean in 2005, or between 50-2706 individual swordfish. However, when it did occur it could affect the equivalent of 50% or more of the swordfish catch.

[A1-13] Spain (IEO: Tenerife)

Data from scientific observers aboard 2 Spanish surface longliners fishing in international waters of the South Western Indian Ocean from December 2004-December 2005 were used to characterize depredation. Overall the depredation rate was about 2.6% by number. It varied by species group from 0.14% for sharks to 4.29% for tunas. Marine mammals accounted for 12%, and sharks 79% of the observed depredation by number.

[A1-14] Sri Lanka

This paper provided a description of the fisheries in the EEZ of Sri Lanka, but did not present information about depredation.

[A1-15] Atlantic and Pacific Oceans (The author from Sri Lanka) (Data from Japan, Taiwan & USA)

Scientific cruise data were employed to estimate shark depredation of tunas from the Atlantic and Pacific Oceans. Overall, depredation on tunas was estimated to be 4.0%, but varied from none to 20.8% in the spatial strata considered; with the highest rates observe for equatorial waters. Workshop participants noted that the data analyzed were very old as the paper was published in 1963, and that cetacean predation may have increased since the data were collected. Also, no data were presented for the Indian Ocean.

[A1-16] Indian Ocean (1960s) (I) (The author from Sri Lanka) (Data from Japan)
Depredation rates by sharks and "killer-whales" were estimated from 59,505 longline sets by research cruises, commercial fleets and training operations in the Indian Ocean from 1955-1963. The "killer-whale" category is believed to have consisted of a number of different cetacean species. On those sets suffering depredation by "killer-whales" the average depredation rate was 55% but up to 100% loss was observed. For sets suffering shark depredation an average of 11% and a maximum of 41% of the catch was damaged. There was a positive correlation between fishing effort and the percentage occurrence of "killer-whales" suggests learning was an important element of the problem, and that "killer-whale" depredation was increasing over the period of the study. There was also a positive correlation between shark hooking rates and the percentage of tuna damaged by shark depredation. This would indicate that shark depredation is dependent on the abundance of sharks in the area where sets were made. The workshop noted that the category "killer whales" should be taken as a generic identification, as the fishermen who were reporting may not have been able to distinguish species. Further, the analysis used old data that may not reflect current conditions in the fisheries.

[A1-17] Indian Ocean (1960s) (II) (The author from Sri Lanka) (Data from Japan)
This paper evaluated the depredation of tuna by sharks in the Indian Ocean from longline operations conducted by research vessels during the International Indian Ocean, exploratory cruises of the Fishery Agency of Japan, and observations on vessels operated by Ceylon. The time period over which the data were collected is not given, but must have been pre-1969 when the paper was published. As with A1-16 there was a positive correlation between shark-hooking rates and the percentage of tuna catch damaged. The study concluded that because of the shark and tuna species distributions, shark predation is the highest in the tuna grounds north of 10°S, less between 10°S and 30°S and negligible below 30°S. The workshop noted that the analysis was based on very old data.

[A1-18] British Indian Ocean Territory (BIOT)
Depredation patterns around the Chagos archipelago were estimated from data collected by observers aboard longline vessels operating in the BIOT from 1997-2004, and hook-line survey data from 2000-2002. Shark and cetacean depredation events were identified by bite marks from 1997-1999. Whale damage (attributed to killer whales, false killer whales, pilot whales, and dolphins) to yellowfin tuna averaged 2.5% of the catch for this period, and shark depredation 6.3%. Estimates of depredation rates varied by species and year: from 1.9%-11.2% for bigeye tuna, 0.0 to 9.7% for swordfish, and 0.0 to 8.0% for yellowfin tuna. Some of this variability was attributed to low sample size in some years. Overall depredation rates were estimated to be about 2.6% of all fish landed. It was also noted that 95% of all hooks set came back empty (no bait) which might partly be explained by cetaceans removing the baits.

[A1-22] China (Pacific)
The fraction of longline sets suffering depredation in the Chinese longline fishery in the tropical Pacific was estimated from scientific observer data collected aboard one vessel during the period July 13-November 30, 2003. Bigeye and yellowfin tuna accounted for 80% of the total catch. The fraction of sets in which depredation occurred averaged 10.9% and ranged from 4.5% to 16% by month for the period evaluated. The fraction of total catch lost was not estimated, but for those sets where depredation occurred, the loss was estimated to be 0.93 mt/set. Based on bite marks 10% of the depredation was attributed to sharks and 90% to whales or dolphins.

[A1-23] Mediterranean Sea
A video from the French public TV broadcasting association, THALASSA (a weekly journal upon sea matters on the French State Channel 3) was presented that showed killer-whale depredation of large bluefin tuna in a Spanish handline fishery directed at the species in the Mediterranean Sea.

AGENDA ITEM 2 - CATCH STATISTICS

No working papers were distributed dealing specifically with catch statistics. The discussion started from a "synthesis" of the documents presented in agenda 1, outlining the major uncertainties: quantification of the phenomenon (and its impact on assessments) and identification of the "predator". Workshop participants also noted that while the species contributing to the depredation are not important for stock assessments (which model total removals), the predator species composition will likely be crucial for developing mitigation measures. Such measures are likely to be time-space variable depending on the predator species composition i.e., toothed whales and sharks are unlikely to respond to the same mitigation measures. Accurate information on the numbers and biomass of fish lost to depredation would also allow realistic assessments of the actual economic losses to fishers from this phenomenon.

Better catch statistics that include losses due to depredation are needed for stock assessments to account for fishing mortalities that are not normally included in the landed catch. Alternatives considered included more observer coverage and increased data reporting by fishers. Workshop participants concluded that better observer coverage is the best alternative, and noted some difficulties in asking for more reporting by fishers. Also with respect to the incorporation of estimates of the numbers of depredated fish into stock assessments, some attention needs to be given to issues related to whether the depredation replaces natural mortality, represents prey switching, or some combination thereof, so that the mortality can be properly incorporated in assessments.

The longline catches of yellowfin, bigeye, albacore and swordfish relative to the total catches of these species in the Indian Ocean are shown in Figure 1. The catch of these species by longline increased considerably from 80,000 t (80-90% of the total) to 250-300,000 t (40-50% of the total) in the recent period even as the gear's contribution to total catch declined from 80-90% to 40-50%. Assuming a mean depredation rate of 5-10% of the longline catch implies a large amount of unreported catches. These unreported catches will impact the adequacy of assessments for these species. These losses can be considered as a 'ghost fishing mortality' which has increased with F since the beginning of the longline fishery. Given that cetaceans may be learning, the depredation mortality may have increased at a greater rate than the fishing mortality attributable to longline gear.

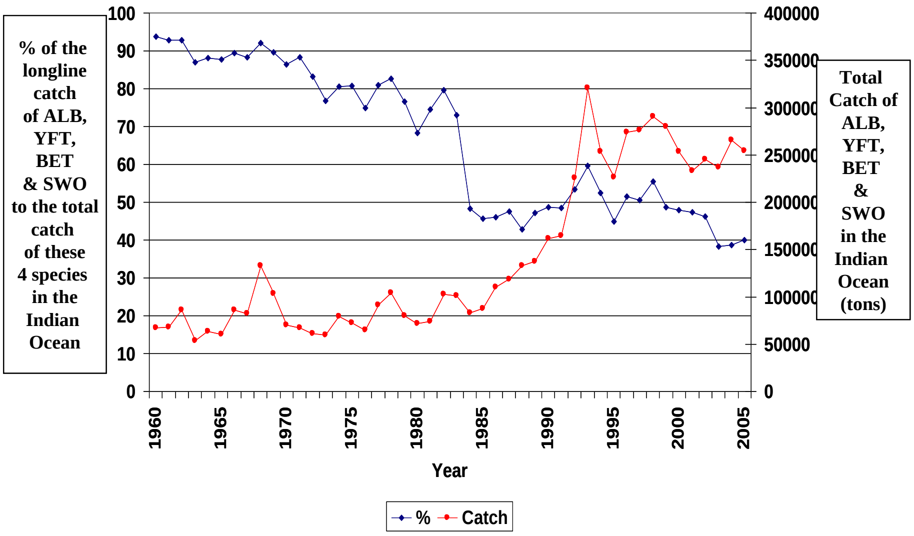


Figure 1. Total catch (tons) of ALB (albacore tuna), YFT (Yellowfin tuna), BET (Bigeye tuna) and SWO (Swordfish) (red line) and the composition (%) of the tuna longline catch to the total catch in the Indian Ocean

The difficulty of estimating depredation rates and amounts is directly linked to the large heterogeneity of the available information, as well of the coverage in time and space, the methodology used (observers or specific forms), and the target species. Obtaining reliable data with a consistent coverage of the concerned fisheries is a major task that should be continued. This, coupled with a good integrated database, will facilitate good estimates of the total depredation rate, the size and species composition of both the retained catch and the losses due to depredation.

It is obvious that onboard observer programs are by far the best way to collect these data; however, they are not always easy to implement, and in general expensive. However, observer's depredation surveys can be quite easily combined within other observer programs, such as those on discards and bycatches implemented by IOTC and other tuna organizations.

The present program included fishermen maintaining records of depredation on specific forms. The information collected is good, but with two major problems: the coverage (space, time and fisheries) can be quite heterogeneous as it is done on a voluntary basis, and the difficulty of relating the observed data to real fishing intensity. The second point makes it difficult to estimate overall depredation rates, as the number of sets (and associated catches) without depredation are generally unknown. Using this information necessitates more information on logbooks associated with the data reported on the depredation forms. It is also difficult to estimate how representative the reported data is with respect to the fishery as a whole. Both approaches were considered as complementary, and can possibly be combined (observers on some boats and forms on others).

Last, the necessity to communicate the detailed information to IOTC was discussed. Unfortunately, at this time, all major fisheries consider this information as confidential and do not release it. This makes it quite impossible to use this information for assessments.

AGENDA ITEM 3 – MITIGATION

[A3-01] Review of Mitigation Methods
Depredation by killer and false killer whales (and perhaps other cetaceans) can in some areas and seasons be a more important problem than depredation by sharks because whales typically completely destroy the marketable portions of the catch they attack, while sharks often leave most of the depredated fish intact and marketable. Also, when depredation occurs on a longline set, whales tend to depredate a larger proportion of the total catch (up to 100%) than sharks. As a consequence, most attention has been paid to mitigating depredation due to whales. Historically, there have been 4 approaches to mitigation:

1. Operations approach

- Escape the presence of predators, by exchanging information among boats and moving away;
- Co-existence (longline and marine mammals live together). Use marine mammals like a sheep dog, chase marine mammals and catch panicked tuna in set nets;
- Decoy (agent provocateur), i.e., to let foreign vessels forced to be attracted by the predators. Ethically not good;
- Non release of left-over foods;

- Drift without lights at night. No attraction, no stimulation, wait until marine mammals move away;
- Line alterations, to stop marine mammals moving along a line e.g., cutting lines, putting out unbaited lines to attract marine mammals and then fish elsewhere; and
- Use all of these methods.

2. Population control

- Use powders in water to deter marine mammals;
- Put chemicals in bait (lithium chloride);
- Scare marine mammals using guns and bombs;
- Scare marine mammals using large and odd shaped dummies; and
- Scare marine mammals using electric shock. Effective for sharks but not tried on marine mammals

3. Physical barriers

- Protection net as used for demersal longliners in Chile, or using a wire string curtain deployed after a fish is caught

4. Acoustic Mitigation

- Active acoustic devices e.g. pingers. Generally small pingers are not effective, as marine mammals learn in time that pingers mean available prey on lines.
- Need acoustic signals with large, strong and changeable patterns that deter marine mammals but not tuna.
- A small boat carrying passive acoustical devices and working with tuna fleets

The best option at present is to use a combination of these alternatives. Select an operational approach as a starting point, and then employ chemical and physical barriers, and/or active acoustic devices.

Workshop participants noted that deep setting of lines in sub-Antarctic has not been effective with sperm whales. Also in South Africa that dummies of sharks may deter shark depredation. The literature looking at active acoustics that are random and variable in amplitudes shows that such acoustics are not a long term deterrent. The concept of using the acoustic effects associated with seismic prospecting was raised. It appears that a lot of anecdotal information is available, which should soon form a good body of data. Whales normally appear to move away from seismic activity, but the information about fish behavior is poor. Also, a huge amount of energy and equipment is required, and this is not really a practical option for fishers at present. It can also cause damage and even death for some marine mammals. One workshop participant reported that some fishermen consider hauling the longline gear at night to be an effective deterrent.

[A3-02] Mitigation of toothed whale depredation on the longline fishery in the eastern Australian Fishing Zone – Geoff McPherson (presented by Bach)

This paper reported the results of a study to minimize depredation of longline catch in the Coral Sea by short-finned pilot and false killer whales by both avoiding depredation on a broad scale and minimizing it on a close-in scale. One recommendation from the study was that the radio buoys used to locate the longline gear be fitted with acoustic sensors to detect the presence of vocalizing toothed whales within a preset radius so that the longline skipper could take appropriate measures to avoid depredation. Active and passive acoustic measures investigated to minimize depredation when whales encounter longlines were not successful. Some active measures elicited adverse responses but the range was too short for commercial longline use. A passive method involving fishing gear components with acoustic reflection capability showed the most promise, but needs more study.

[A3-03] An option for long range acoustic detection of toothed whale depredation on longlines – Geoff McPherson (presented by Bach)
Knowledge of the locations of toothed whales responsible for depredation would help longline skippers to select set locations to avoid whale interactions. This study reported progress on the design of cost-effective methods to identify the presence of toothed whales based on their vocalizations. The use of existing equipment associated with radio beacons would simplify the process for fishermen as no operation changes would be required. However, if multiple herds are present, some semi-automated signal isolation and enhancement software and associated hardware would be needed to increase the proximity detection range.

[A3-04] Development of passive acoustic tracking systems to investigate toothed whale interactions with fishing gear ? – Geoff McPherson (presented by Bach)
False killer whales and short-finned pilot whales are major participants in toothed-whale depredation in the Coral and Tasmanian Seas. This study investigated passive acoustic tracking of toothed whales with a high-resolution integrated passive acoustic tracking system to provide an accurate estimation of the source location of whale vocalizations. The integrated passive system is designed to provide location estimates of vocalizing toothed whales close to the gear with sufficient resolution to detect events as depredation of catches occur. This resolution is important to test the effectiveness of acoustic, mechanical and chemical approaches to mitigate depredation. System trials for inshore toothed whales showed similar accuracy for two methods. Offshore tests have not yet been conducted.

Workshop participants discussed whether the good recordings that can be used as a reference exist for all marine mammals. Such recordings exist for some species, but many species contributing to depredation have not been well studied acoustically. More targeted research is needed to characterize the acoustics of these species and the behaviors associated with the various vocalizations.

[A3-05] Device Demonstration – Guinet (presented by Vely)
A device that can be placed on branch lines and deployed after a fish is caught was demonstrated. The device contains a number of plastic streamers that will slide over the fish after it is caught with the intent of deterring marine mammals from attacking the caught fish. The device needs to be tested under operation conditions to ascertain its efficacy. The device has been developed in collaboration between French and Seychelles scientists. A workshop participant reported that the Australian government is currently funding the development of a similar device in Samoan fisheries.

[A3-06] Learning to coexist with whales – the Chilean experience in the Patagonian toothfish fishery. Moreno (presented by Gales).
A new fishing technique was described, called the mixed or Chilean system, adapted from an artisanal fishery for Patagonian toothfish. The artesianal system was modified to include a net sleeve that is placed on secondary vertical lines, which has practically eliminated depredation by Sperm and Killer Whales. In addition to this, the 15-m vertical lines carry a weight at the end, which provides a sink rate of 0.8 m/s. This causes the line to sink immediately behind the vessel preventing seabirds from seeing the baited hooks at the surface. Additionally, this system does not reduce catch per unit effort (CPUE) when compared to the traditional Spanish longline system.

The performance of this fishing technique was evaluated with regard to both seabird mortality and depredation of Sperm and Killer Whales on catch rate between September and December 2006. The gear was shown to be extremely effective, totally eliminating seabird mortality and significantly reducing depredation by marine mammals. Shark depredation was not an issue in this fishery.

[A3-07] On the invention of effective and perspective device (protective net) for the mitigation of depredation of fishes in longline fisheries. Pshenichnov (presented by **Romanov).**
This paper described the development and deployment of gear similar to that described in the previous paper for use in the Patagonian toothfish fishery in the waters off Argentina in the Atlantic Ocean. The device successfully reduced depredation by Sperm Whales

AGENDA ITEM 4 – RELATIONS WITH MARINE ECOLOGY

[A4-01] Ecological interactions between fisheries and marine mammals in the Indian Ocean. Do whales and fisheries compete for resources? – Nick Gales
Whales have the potential to interact with fisheries directly (e.g. bycatch and depredation) and indirectly (e.g. competition for a shared resource). While mitigating the direct interactions represent substantial challenges for fishery management, given adequate resources they are relatively easy to quantify and understand. The indirect, ecological interactions are vastly more difficult to measure and understand, primarily due to the complexity and dynamics of marine food webs and ecosystems.

Attempts to understand these ecological interactions have been developed using data on diet and with models that attempt to simplify the workings of ecosystems. However these models cannot yet accommodate the complexity of the systems nor deal with the uncertainty that arises from imperfect knowledge. While science attempts to better model marine ecosystems, a number of hypotheses and model outputs have been proposed and are being represented in some forums as being sufficiently robust that management should respond to them. Among these are suggestions that consumption by whale populations is directly limiting fishery yields. Evidence for this is based on whales and fisheries targeting a common prey, and modeling the results of the interactions between the fishery, the whales and the shared prey.

This paper discussed the relationship between ecological competition and the simple circumstances of feeding on (or fishing for) a common prey. The spatial and temporal aspects of consumption by cetaceans in the Indian Ocean were also discussed, and the plausibility of ecological competition occurring with fisheries investigated. The conclusions clearly demonstrate that ecological competition between whales and fisheries in the Indian Ocean is highly unlikely, and that if it occurs at all, it does so at transient and highly localized scales. As a result, scientists, managers and fishermen who deal with interactions between cetaceans and fisheries should focus on the more important and influential direct interactions such as mitigation of bycatch and depredation, rather than worry about whether direct competition is occurring.

[A4-02] Fine scale behavioral and underwater video observations of sperm whales near longline fishing vessels in the Gulf of Alaska and recommended deterrents to avoid depredation – Janice Straley (Gales)

A study among fishermen, scientists and managers collected data on depredation of sablefish (*Anoplopoma fimbria*) demersal longlines by sperm whales (*Physeter macrocephalus*) in the Gulf of Alaska, 2003-2007. The goals were to characterize the whales involved, determine the mechanics of depredation, and recommend changes in fishing behavior to reduce depredation. At sets when whales were present (N=39), 71% had evidence of depredation. Genetics determined the whales (N=19) were male. Bayesian mark-recapture analysis estimated 123 (94, 174; 95% Confidence Interval) in the study area. Passive acoustic recorders permitted monitoring of the underwater noise environment, including sperm whale activity, before and during longline recovery. Engine cavitation noise was found to correlate with changes in acoustic activity of sperm whales, while vessel hydraulics or cable strum was not. Three passive deterrents were tested: decoy anchorlines, hydrophones for passive acoustic monitoring and minimizing engine cycling during the haul. Fewer interactions occurred and whales were less likely to follow vessels using one or more of these strategies. To observe how animals remove individual fish, an underwater video camera was attached to a longline that had been partially hauled and then lowered between depths of 90m and 120 m, with sablefish attached 2-4 m above the camera. Hydrophones were deployed at 17 m depth during the 40-60 minute deployments, and mounted 1.3 m below the camera. During two encounters, one whale investigated the line, producing characteristic "creak" sounds that were recorded on the three hydrophones, and which were subsequently time-aligned using vessel noise in order to permit acoustic tracking. A second whale interacted with two fish within 4 m of the camera, but only the camera hydrophone was available. Acoustic analyses show the maximum click production rate is 33 clicks/second and echolocation is used by sperm whales to target prey.

Workshop participants noted from the presentation that whales may remove the whole fish from the hook. Consequently, to the extent the count of fish heads is used to estimate the impact of depredation the magnitude of the problem may be underestimated.

PANEL DISCUSSIONS

Agenda item 1 – Situation with regard to depredation

Depredation is an important issue in the Indian Ocean pelagic longline fisheries. The level of depredation is highly variable by area, target species and fleet (Table 1). At least two symposia on depredation on fishing gears have been held recently (Samoa, 2002 and British Columbia, Canada, 2006); however, there was no attempt to disseminate the main findings from these symposia here, and our discussions reiterate findings of the earlier symposia:

- There is no unified terminology for depredation. Most of the presentations applied various non-standardized terms and often referred to the same metric with different terms or used the same term to refer to different metrics:
- The phenomenon itself was termed 'Predation' and 'Depredation' as well as 'Interactions', 'Mutilation', 'Damage', etc.
- Most of the presentations applied different, usually incompatible metrics to quantify depredation. This highly complicates comparisons of depredation even on same types of fisheries. Existing reports quantify depredation as:

- Damaged fish as a percentage of the catch in affected sets exclusively
- Damaged fish as a percentage of the catch of particular species
- Damaged fish as a percentage of the overall number of caught fish or weighed catch
- Ratio of fishing operations affected to total number of fishing operations
- Number of fish damaged by particular predator irrespectively to fishing effort
- Economic loss to fisheries:
    - Losses of catch
    - Fishing gear damage
    - Revenue lost to industry
- Some studies focused on single predator groups like cetaceans or sharks, which makes impossible to estimate overall level of the problem for the fisheries.

We should accept unified terminology in accordance with recent recommendations (Donoghue et al., 2003, Gilman et al., 2007):

- To use the term '**depredation**' as "*the partial or complete removal of hooked fish or bait from fishing gear…* by predators…" to distinguishing depredation from '**predation**', i.e. "*the taking of free swimming fish (or other organisms)…*"
- To used standardized indexes of depredation or to present information, which allow to calculated such indexes
- Indexes: a). Damage rate: ratio of operations affected to total number of operations, b). Depredation rate: ratio of fish affected in all the operations to total number of fish caught (total and for target species or by principal groups)
- Information for indexes calculation: Number of operations affected, total number of operations, total fishing effort in number of hooks, number of fish damaged by species, total number of fish caught by species.

Other estimates like value of economic losses or gear damage could be very useful.
No effective mitigation measures were presented in the national reports.

It was clear from the discussions that there is a need to develop a guide for predator identification that uses the wound marks caused by predators during depredation events, and to verify the veracity of using these traces to identify the predators. Also, it is essential to provide a better distribution of identification guides for marine mammals.

Table 1. Summary of the current level of the depredation problem (as it was presented plenary or in the papers).

Country	Type of fishries	Area/Target species	Predator	Depredation metric							
				Damage rate = operations affected / total number of operations	Depredation rate = fish damaged / total number of fish caught (including damaged)		Target depredation rate = target fish damaged / total number of target fish	Number of fish per set with specific damage	Loss of catch (species specific or total)	Depredation index = fish damaged per 1000 hooks	Losses
					Depredated sets	All sets					
Australia	Commercial	East coast of Australia / Tuna, swordfish	Cetaceans, sharks, others			7.3%			0-15%		Gear damage 33000-49000 AU$
France (La Reunion)	Small-scale commercial	Southwestern and western equatorial waters Indian Ocean / Swordfish	Cetaceans			4.3%			3.7-5.5%		
			Sharks			3.2%			3.0-3.5%		
India	Research	Arabian Sea, Andaman & Nikobar / Tuna, Swordfish	All (Cetaceans + Sharks)		By areas 12.8-24%*, 15.3-16.7%*	3.0%			12-36%*		20% landings** 45,000 tonnes
Japan	Large scale commercial	Atlantic, Indian, Pacific / Tuna	Cetaceans and sharks, focused on cetaceans	No index used, number of operations with damage reported and number of damaged fish reported				5.1%***	2-3%		
Seychelles	Small-scale commercial		All			19.4%			19%	4.2	Lost revenues 1,000,000 € for 1995-2006
			Cetaceans	16%		10.3%				15.3*	
			Sharks	41%		9.10%				3.8*	

* in the sets affected
** in weight
***in depredated sets only

Table 1. (continued) Summary of the current level of the depredation problem (as it was presented plenary or in the papers).

Country	Type of fisheries	Area/Target species	Predator	Depredation metric							
				Damage rate = operations affected / total number of operations	Depredation rate = fish damaged / total number of fish caught (including damaged)		Target depredation rate = target fish damaged / total number of target fish	Number of fish per set with specific damage	Loss of catch (species specific or total)	Depredation index = fish damaged per 1000 hooks	Losses
					Depredated sets	All sets					
South Africa	Commercial, small-scale	Southern Atlantic/Indian, SA EEZ / Tuna, Swordfish	Killer whale		10-20%	0.5%			10-20%***		
USSR	Research	Indian Ocean / Tuna	All	26.8%		6.8%	11.4%	4.0%	6.8% Overall	2.32	
			Cetaceans	1.6%	44%	0.8%	1.5%	7.6%	44-56%*	0.27	
			Sharks	25.6%	16%	6.0%	9.9%	3.7%	13-16% *	2.05	
Spain	Commercial	Atlantic, Indian, Pacific / Swordfish	False killer whale				0.5-2.6%		Overall 0.5-2.6%	0.02-0.18	
									Up to 10%		
Spain	Commercial	Indian / Swordfish	All, also presented by predators			1.7% 1.3%**	2.6% 2.1%**		3.8-4.3%		
Sri Lanka	Commercial	Sri Lanka EEZ / Tuna	No data on depredation presented								
UK			All			2.6%			5.8-8%		
			Cetaceans				2.5%	2-3%			
			Sharks				6.3%	3.8-5%			

* in the sets affected
** in weight
***in depredated sets only

Agenda item 2 – Improvement of catch statistics

Catch statistics need to be improved to address essentially 2 complementary issues:

- Depredation impacts on catch statistics and the importance of this information for stock assessment
- The need for further information on the species being depredated and the species causing the depredation in order to develop mitigation measures.

The importance of observer information and the need for observer training were highlighted (need to avoid preconceptions affecting reporting). Species identification guides are becoming more readily available.

Observer programs have a range of objectives and while some aspects of fisheries monitoring are well covered there is a need to consider the focus of the programs. It was noted that although there are some national observer programs in place, there are a number of fleets operating in the Indian Ocean with poor coverage by observers.

A strong recommendation from the meeting was for improved overall observer coverage. It is recognized that this is the only way to collect certain types of information. In the CCAMLR region it is a requirement that there is 100% observer coverage in the finfish fisheries. Although this level of coverage is unlikely in the short term, there is a need for improved and more extensive observer programs in the Indian Ocean and a preference to move towards a regional observer program. There is the potential for coastal states licensing foreign vessels to fish within their EEZ's to require a specified level of observer coverage.

Much of the existing information is based on assumptions about which cetaceans are responsible, i.e. reporting of depredation being by pilot whales or false killer whales when it could be any of a range of similar sized 'black' whales. Similarly there are often assumptions that if there is a head only on the hook then it is the result of a cetacean rather than a shark.

A range of approaches in presenting depredation rates was seen in the papers at the meeting. It was evident from some of the presentations that when considering depredation rates, information from sets where there is no depredation should be incorporated. Similarly, rates are sometimes presented on the basis of damaged fish without accounting for empty or lost hooks.

With respect to catch statistics, it was noted that impacts are mainly on the large tunas taken by longline and we have to be able to account for this in historical catch information. The impact of incorporating depredation information into stock assessments is not clear as it will depend on a number of factors including the species involved and changes over time. However, it is desirable that all sources of mortality be accounted for in future assessments.

Other considerations for stock assessment include:

- The impacts of depredation on species composition
- Potential for species switching
- How should depredation be accounted for as fishing mortality?

It was suggested that more information should be collected through logbooks without a major impost on the industry, i.e. information on fish loss or damage would be a relatively simple addition to logbooks. The need for additional requirements being placed on the fishing industry was questioned. The issue has been well known for some time and progress with mitigation is needed. The level of depredation suggested by some of the presentations and the value of lost catch indicate the potential cost benefit of mitigation and additional research.

Agenda Item 3 – Mitigation

The focus on mitigation dealt with depredation by cetaceans for reasons already mentioned. Three main categories of mitigation were discussed. These included 1) avoidance of marine mammals, 2) Marine mammal deterrents, and 3) physical protection of catch

Avoidance of marine mammals

- Techniques that can be implemented to avoid marine mammal interactions.
  - Passive acoustic detection (and tracking)
  - Visual detection
  - Control of 'cues' that attract MMs
    - Propeller cavitation
    - Waste dumping
- Issues
  - Range of acoustic detection needs improvement
  - Targeting marine mammal aggregations

Marine mammals deterrents

- Techniques
  - Active acoustics
    - Acoustic harassments

      (anecdotal evidence suggested that recent military conflicts naval sonar had impacted marine mammal abundance / depredation in some areas)
    - Pingers
- Model sharks, whales etc
- Direct harassment – herding
- Shooting and culling (not an acceptable option)
- Issues (Acoustics and models)
  - Poor performance in other marine mammal interactions
  - High level of technical and operational maintenance

Techniques for the physical protection of catch

- Devices
  - "Net sock" – Chile and Ukraine
  - "Streamer cone" – Guinet *et al*
- Issues
  - Successfully deployed in demersal fishery
  - Not yet tested for pelagic fishery
  - Need for investment in gear design, experimental design and testing in fishery
  - Indian Ocean – Pacific collaboration?

Workshop participants discussed the need to develop a list of relative priorities for addressing depredation. The discussion focused on cetacean mitigation and there was in fact no mention of mitigation to reduce shark depredation. Acoustic methods will be ineffective for sharks. A shark is less likely to be deterred by a net covering. Electro-magnetic methodologies including the use of rare-earth magnets may deter sharks. This will also have the effect of reducing shark capture which may not be desirable to fishers. The relative cost and benefit of reducing shark depredation of commercially valuable catches versus the decrease in shark capture needs to be considered.

Agenda Item 4 – Relation with the marine ecosystem.

The pelagic marine ecosystem is complex with different trophic levels and species interrelated by the resources they consume (Figure 2). This is reflected by the overlaps in diets of the various animal taxa, that create complex food webs. Common items in the diets of species do not necessarily mean competition. The marine ecosystem is also spatially-structured, and exhibits fluctuations at various timescales. Cetaceans that participate in depredation are at or near the top of the food web. They are opportunistic and efficient predators and smart animals that can identify and react to sounds emitted from fish schools and fishing vessels and learn new behaviors to take advantage of new sources of food. Baleen whales feed on krill and possibly compete with other components of the food web (e.g., Engraulids, *Cubiceps*, pelagic crustaceans, etc.), but it is unlikely they directly compete for food with tuna and tuna-like species. Deep-diving toothed whales such as sperm whales feed at great depths on big size prey items and have virtually no common food with tuna and tuna-like species. Tuna also may avoid sperm whale pods. Other toothed whales do have common food with that of tuna. They also forage over common depth ranges, perhaps best illustrated by the strong and well-known co-occurrence patterns of dolphins and tuna in the East Pacific. Thus, there is at least a potential for trophic competition among these species. No information was presented at the workshop concerning the trophic dynamics of shark species.

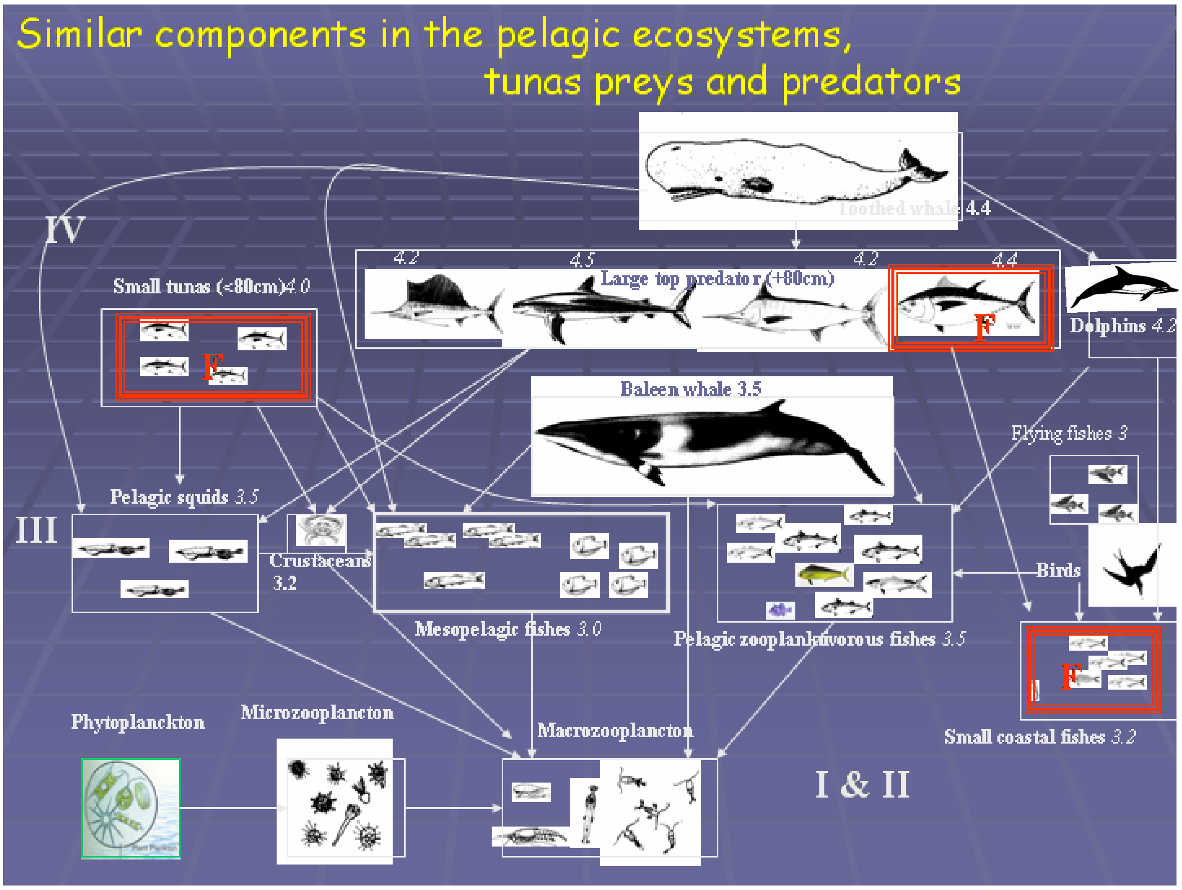


Figure 2. Schematic representation of the pelagic food web (by Alain Fonteneau, IRD, France)

Just as there are spatial variations in the distribution of targeted species, there are spatial patterns in depredation. For example, depredation hotspots exist around seamounts. These hotspots highlight the existence of higher pelagic diversity and species abundances that provide more prey for tuna and other apex predators. Evidence was presented that suggested longline and purse seine catches in the Indian Ocean follow concentrations of sea-surface chlorophyll which reflect the primary production patterns. These distributions have seasonal spatial structures and vary with longer term phenomena such as El Nino and La Nina as reflected by spatial and seasonal interannual anomalies of measures of primary production. It was suggested that longline effort may be a proxy for distributions of cetaceans with both following the trophic influences of shifting patterns of primary production.

Despite numerous interactions cases described in the papers presented, it has been noted that in any case marine mammals species identify as responsible of depredation were not threatened by the longline fisheries.

Citations

Anonymous. 2006. Symposium on fisheries depredation by killer and sperm whales: behavioural insights, behavioural solutions.October 2-5, 2006, Pender Island British Columbia, Canada. Vancouver Aquarium [http:/www.killerwhale.org/depredation/index.htm].

Donoghue, M., Reeves, R. R., Stone, G. 2003. Report of the workshop on interactions between cetaceans and longline fisheries, Apia, Samoa: November 2002. New England Aquarium Aquatic Forum Series Report 03-1. 45p. (http://neaq2.securesites.net/ scilearn/conservation/ LonglineReport2002.pdf).

Gilman, E., Clarke, S., Brothers, N., Alfaro-Shigueto-J., Mandelman, J., Mangel, J., Petersen, S., Piovano.S., Thomson, N., Dalzell, P., Donoso, M., Goren, M., Werner, T. 2007. Shark Depredation and Unwanted Bycatch in Pelagic Longline Fisheries: Industry Practices and Attitudes, and Shark Avoidance Strategies. Western Pacific Regional Fishery Management Council, Honolulu USA (www.wpcouncil.org or http://www. Killer-whale.Org/ depredation/index.html).

WORKSHOP RECOMMENDATIONS

Workshop participants **appeal strongly** to resource managers and others responsible for sponsoring, planning and conducting research that recommendations need to **stimulate action**! These recommendations include:

1. Because mitigation is a key issue:
    a. Pursue the further development of current mitigation suggestions.
    b. The Ecosystem and bycatch working party should review progress on depredation mitigation regularly.
    c. Further development of mitigation is necessary which will need to be taken up by national or regional programmes.
2. Encourage the submission of historical data and current catch and effort data (some of the major stakeholders have not submitted data which limits the present analysis).
3. All data used in the country reports to be made available to IOTC within one month.
4. IOTC should follow up with the commission to develop a regional observer programme.
5. Progress is also needed on potential ecological interactions with fisheries that consider both cetaceans AND sharks

Appendix 1. Agenda

Welcome by workshop organizers

Objectives and remarks

Elections of the Chair, rapporteurs, and panelists

Greetings from the Chair

Discussion of terminology: “depredation” or “predation”

Workshop topics:

- A1. Situation with regard to depredation
  - Indian Ocean
  - Other waters
- A2. Catch statistics
- A3. Mitigation
  - Acoustic
  - Operational
- A4. Relations with marine ecosystems

Panel discussions

- A1. Situation with regard to depredation
- A2. Improvement of catch statistics
- A3. Mitigation methods
- A4. Relation with the marine ecosystem.

Closings

Appendix 2. List of participants

List of participants								
cumm. no. participants	registration number	Country	Last Name	First Name	Agency	E-mail address	Tel	Fax
1	AUS-1	Australia	McLOUGHLIN	Kevin	BRS	Kevin.Mcloughlin@brs.gov.au	61-2-62724015	61-2-62724014
2	AUS-2		GALES	Nick	Australian Centre for Applied Marine Mammal Science	Nick.Gales@aad.gov.au	ph: 61-3-62323437 mobile: 0409-562159	61-3-62323351
3	AUS-3		BAKER	Barry	Agreement on the Conservation of Albatrosses & Petrels	barry.baker@latitude42.com.au	61 (0)3.6267.4079 mobile: 0418.626.711	?
4	BAN-1	Bangladesh	SAHA	Jayanta	Laxmi Agro Fisheries Complex Ltd.	sahajayantak@yahoo.com	88-02-9338781	88-02-9334915
5	FRA-1	France	ROMANOV	Evgeny	IRD	evgeny.romanov@mpl.ird.fr	33 (0)4 99 57 32 05	33 (0)4 99 57 32 95
6	FRA-2		MARSAC	Francis	IRD	marsac@ird.fr	33 (0)4 99 57 32 26	33 (0)4 99 57 32 95
7	FRA-3	France (La Réunion)	BACH	Pascal	IRD	Pascal.Bach@ifremer.fr	262 (0) 262 55 47 28	262 (0) 262 43 36 84
8	FRA-4		GUENNEGAN	Yvon	IFREMER	yvon.guennegan@ifremer.fr	262 55 47 26	(0) 262 43 36 84
9	FRA-5	France	FONTENEAU	Alain	IRD	fonteneau@ird.fr	33499573200	33499573295
10	FRA-6		PIANET	Renaud	IRD	renaud.pianet@ird.fr	33 99 57 32 9 5	33 99 57 32 95
11	IND-1	India	VARGHESE	Santha	FSI	santhavarghese@hotmail.com	?	?
12	IND-2		VARGHESE	Sijo	FSI	varghesefsi@hotmail.com	?	?
13	IOT-1	IOTC	ANGANUZZI	Alejandro	IOTC	aa@iotc.org	248-225494	248 224364
14	IOT-2		O'BRIEN	Chris		cob@iotc.org		
15	IOT-3		HERRERA	Miguel		miguel.herrera@iotc.org		
16	IOT-4		POISSON	Francois		francois.poisson@iotc.org		
17	JPN-1	Japan	NISHIDA	Tom	NRIFSF	tnishida@affrc.go.jp	81(Japan)-54-336-6052	
18	JPN-2		FUJIWARA	Shunji	OFCF	sf@iotc.org	248-225494	248 224364
19	JPN-3		KAWAHARA	Isao	OFCF	ositoisao@hotmail.com	?	?
20	JPN-4		ABE	Ken-ichiro	OFCF	kenichiroabe47@hotmail.com	?	?
21	MAL-1	Malaysia	BASIR	Samsudin	FISHERIES RESEARCH INSTITUTE	s_basir@yahoo.com	6 05 - 691 4742	6 05 - 691 4742
22	SEA-1	SEAFDEC	SIRIRAKSOPHON	Somboon	SEAFDEC	somboon@seafdec.org	(66) 2425-6140	(66) 2425-6111
23	SEY-1	Seychelles	VELY	Michel	Dept of Environment	mobydick@seychelles.sc	?	?
24	SEY-2		DORIZO	Juliette	SFA	jdorizo@sfa.sc	?	?
25	SEY-3		AUMEERUDDY	Riaz	SFA	raumeeruddy@sfa.sc	?	?
26	SEY-4		GIROUX	Florian	SFA	?	?	?
27	SEY-5		LUCUS	Vincent	SFA	vlucas@sfa.sc	?	?
28	SEY-6		GAMBLIN	Caroline	SFA	?	?	?
29	SEY-7		ROWAT	David	Marine Conservation Society	david@mcss.sc	(248) 345445 Mobile; +(248) 513671	(248) 344223
30	SEY-8		GENDRON	Gilberte	Department of Environment	g.gendron@env.gov.sc	?	?
31	SEY-9		HOARAU	Beatty	Fishing Boat Owners Association	beatty@seychelles.sc	?	?
32	SEY-10		HOARAU	Patrick	Oceana Fisheries	oceana@seychelles.net	?	?
33	SEY-11		PAYET	Rondolph	SFA	rpayet@sfa.sc	?	?
34	SF-1	South Africa	PETERSEN	Samantha	Birdlife Intn.	seabirds@birdlife.org.za	27 21 425 3440	27 21 425 3440
35	SPA-1	Spain	ARESO	Juan Jose	Spanish Fishereis office	jjareso@seychelles.net	?	?
36	UK-1	UK	ANDERSON	Charles	independent scientist	anderson@dhivehinet.net.mv	00-960-3327024.	

List of participants : paper submission only (no participations)								
Cum no. of participants	reg. no. for non participants	Country	Last Name (First or corresponding author)	First Name	Agency	E-mail address	Tel	Fax
38	AUS-NP1	Australia	McPHERSON	Geoff	OceanWatch (Australia)	mcpherson.geoff@gmail.com	07 4032 2618 or Mobile 0401 266 454	?
39	CHIN-NP1	China	DAI	Xiaojie	Shanghai Fisheries University	xjdai@shfu.edu.cn	?	?
40	CHIL-NP1	Chile	MORENO	Carlos	Universidad Austral de Chile	cmoreno@uach.cl	56-63-221486	56-63-216304
41	FRA-NP1	France	GUINET	Christophe	Centre d'Etudes Biologiques de Chizé	christophe.guinet@cebc.cnrs.fr	33-(0)5.49.09.78.39	33-(0)5.49.09.65.26
42	SPA-NP1	Spain	MEJUTO	Jaime	IEO (A coruna)	jaime.mejuto@co.ieo.es	?	?
43	SPA-NP2	Spain	de MOLINA	Alicia	IEO (Tenerife)	alicia.delgado@ca.ieo.es	34922549400	34922549554
44	SL-NP1	Sri Lanka	SIVASUBRAMANIAM	K.	ex FAO	krsiva@sltnet.lk	?	?
45	SL-NP2		JAYASOORIYA	J.A.D.B.	Ministry of Fisheries	JADBJayasooriya@fisheries.gov.lk	Office – 011 2381367, Hand phone – 077 6208737	?
46	UK-NP1	UK	CLARK	James	MRAG Ltd	j.clark@mrag.co.uk	44 (0)20 72557790	44 (0)20 74995388
47	UKL-NP1	Ukraine	PSHENICHNOV	Leonid	Southern Scientific Research Institute of Marine	lkp@bikent.net	380 6561 21012	380 6561 61627
48	USA-NP1	USA	RIVERA	Kim	NOAA	Kim.Rivera@noaa.gov	907-586-7424	907-586-7012
49	USA-NP3		LIDDLE	Joe	Univ of Alaska	Joe.Liddle@uas.alaska.edu	?	?
50	USA-NP4		STRALEY	Jan	Univ of Alaska	Jan.Straley@uas.alaska.edu	9077477779	9077477741
51	KEN-NP1	Kenya	NDEGWA	Stephen	Fisheries department	ndegwafish@yahoo.com	254412315904	254412315904
52	KEN-NP2		MAKOGOLA	Okumu		okumumak@yahoo.co.uk		

Appendix 3. List of presentations

A1-01 IOTC Secretariat. Status of IOTC Databases for predation data

A1-02 De Fries, A, J. Hender and K. McLoughlin. Informal review of observer data from the Australian fishing zone (Indian Ocean) with regard to depredation from pelagic longline operations.

A1-04 Poisson, F, C. Marjolet, K Mete, and M. Vanpouille. Evaluation du phenomene de depredation du aux mammiferes marins.

A1-06 Nishida,T and Y. Shiba. Report on the predation survey by the Japanese commercial tuna longline fisheries (2000-2005).

A1-05 Varghese, S., S. P. Varghese, and V. S. Somvanshi. Depredation in the long line fishery of the Indian waters.

A1-07 Ndegwa, S. and O. Makogola. Status of tuna depredation in Kenya.

A1-09 Rabearisoa, N., R.Aumeeruddy, J. Dorizo, M. Vely, F. Giroux, O. Adam, and C. Guinet. Depredation by sharks and cetaceans on semi-industrial pelagic longliners targeting swordfish in the Seychelles.

A1-10 Williams, A.J., S.L. Petersen, M. Goren, and B.P. Watkins. Sightings of killer whales Orcinus orca from long-line fessels in South African waters; a preliminary review and consideration of the regional conservation status of this species.

A1-11 Romanov, E., D Garertner, P. Bach, and N. Romanova. Depredation on pelagic longlines in the Indian Ocean: an analysis of the Soviet historical database (1961-1989) on tuna research.

A1-12 Ramos-Cartelle, A., and J. Mejuto. Interaction of the false killer whale (*Pseudorca crassidens*) and depredation on the swordfish catches of the Spanish surface longline fleet with special reference to the Indian Ocean.

A1-13 Artiz, J.,A. Delgado de Molina, M. L. Ramos, and J.C. Santana. Some data of predation from the pilot action RAI-AP-08/2004 by two Spanish surface longline ships in South-western Indian Ocean during 2005..

A1-14 Jayasooriya, J. A. D. B. Studies of the tuna depredation of economically exclusive zone (EEZ) of Sri Lanka.

A1-15 Sivasubramaniam, K. On the sharks and other undesirable species caught by tuna longline.Records oceanic works in Japan Volume 7, Number 1, March 1963.

A1-16 Sivasubramaniam, K. Predation of tuna longline catches in the Indian Ocean, by killer-whales and sharks. Bull. Fish Res. Stn, Ceylon, Volume 17, Number 2 pp 221-236, Decenber, 194.

A1-17 Sivasubramaniam, K. New evidence on the distribution of predatory pelagic sharks in the tuna grounds of the Indian Ocean. Bull. Fish. Res. Stn., Ceylon Vol 20, pp65-72, 1969.

A1-18 Clark, J. M., J. Roberts, and C. Mees. Depredation of fish caught on tuna longlines in the BIOT area.

A1-22 Dai, X, L. Song, and L. Xu. Observation of predation occurred in the Chinese longline fishery in the tropical Pacific Ocean based on observer data.

A3-01 Nishida, T. Presentation of the various mitigation measures.

A3-02 McPherson, G., C. McPherson. P. Turner, O. Kenny, A. Madry, I. Bedwell, D. Cato, and D. Kreutz. Mitigation of toothed whale depredation on the longline fishery in the eastern Australia fishing zone.

A3-03 Clark, G., G. McPherson, and D. Kreutz. An option for long range acoustic detection of toothed whale depredation on longliners.

A3-04 McPherson, G., C. Clague, P. Turner, C. R. McPherson, A. Madry, I. Bedwell, and W. H. Cato. Development of passive acoustic tracking systems to investigate toothed whale interactions with fishing gear.

A3-05 Guinet, C. Demonstration of the pingers.

A3-06 Moreno, C. A. R. Castro, and L Mujica. Modification of fishing gear in the Chilean Patagonian toothfish fishery to minimize interactions with seabirds and toothed whales.

A3-07 Pshenichnov, L. K. and A. K. Zaitsev. On the invention of effective and perspective device (protective net) for the mitigation of depredation of fishes in longline fisheries.

A4-01 Gales, N. Biological competion between whales and fisheries.

A4-02 Straley, J., A. Thode, K. Folkert, V. O'Connell, L. Behnken, S. Mesnick, and J. Liddle. Fine scale behavioral andunderwater video observations of sperm whales near longline fishing vessels in the Gulf of Alaska and redommended deterrents to avoid depredation.

A4-03 Dietrich, K. S., V. R. Cornish, K. S. Riveria, and T. A. Conant. Best practices for the collection of longline data to facilitate research and analysis to reduce bycatch of protected species.

Appendix 4. Abstracts

[A1-01]

STATUS OF IOTC DATABASES FOR PREDATION DATA

IOTC Secretariat

This document describes the status of information at the IOTC Secretariat on the predation by marine mammals and sharks on the catches made by commercial longliners.

In the late 1990's, predation problems in the western Indian Ocean become an important issue and the IOTC Scientific Committee and Commission recommended an examination into predation be undertaken. A "Survey form of predation on distant water tuna longline fisheries" was proposed by Japan in the document presented by Japan during the third session of the Scientific Committee (see the next page).

Twelve fleets showed their interest in participating in this large scale survey by providing data already collected or initiating dedicated surveys.

In November 2006, Japan informed the SC about plans for a workshop on the predation in tuna longline fisheries to discuss the results and implications of the five year predation survey on tuna longline fisheries.

As of June 2007, five countries: France (Réunion island), Mauritius, India, United Kingdom and the Seychelles have provided data while two major fishing countries: Japan, Taiwan, China, operating in the Indian have classified their information confidential due to the complexity and the sensitivity of the predation by marine mammals issue. Other countries are still working on their datasets prior releasing them.

The quantity of information available at the IOTC Secretariat is very low (Table 2). Some data may not be easily comparable as some institutions used different data collection protocols. For example, in Mauritius, La Reunion and in the Seychelles data were extracted from logbooks as fishing masters and crew demonstrated their willingness to co-operate to this program and agreed to collect information required on a voluntary basis. In other countries this task was completed by observers.

Overall, the data covers 1997 to 2007 and while in some years there is data from more than one country, from 1997 to 2000, there was only one country collecting information. On the other hand coverage rates were generally low.

Survey form of predation on distant water tuna longline fisheries

<u>P l e a s e fill this form when predation occur</u>

Name of Ship		Name of home port	

On the 1st day of every month, please fax survey forms to Union or Association via fishery companies (for September-November, 2000). From December, please submit to a Union or Association with catch report required by the Minister of Agriculture, Forestry and Fishery, via fishing companies whenever your boat arrive at domestic or foreign ports)

Date of Fishing			Noon position						Damaged species (select no.) and number of damaged fish (example: ③2, ⑤1)	Name of predators (choose alphabet below) (fill out if species names known)	Others (*) (other important information)
Year	Month	Date	Latitude			Longitude					
2000			deg.	min.	N・S	deg.	min.	N・S			
2000			deg.	min.	N・S	deg.	min.	N・S			
2000			deg.	min.	N・S	deg.	min.	N・S			
2000			deg.	min.	N・S	deg.	min.	N・S			
2000			deg.	min.	N・S	deg.	min.	N・S			
2000			deg.	min.	N・S	deg.	min.	N・S			
2000			deg.	min.	N・S	deg.	min.	N・S			
2000			deg.	min.	N・S	deg.	min.	N・S			
2000			deg.	min.	N・S	deg.	min.	N・S			
2000			deg.	min.	N・S	deg.	min.	N・S			

species code: ①northern bluefin, ②southern bluefin ③albacore, ④bigeye, ⑤yellowfin, ⑥swordfish, ⑦striped marlin, ⑧blue marlin, ⑨black marlin, ⑩sailfish, ⑪skipjack, ⑫sharks, ⑬not identified, ⑭others

Predator code [A] killer whale, [B] false killer whale, [C] other whales (including dolphin), [D] sharks, [E] not identified

Examples of 'Others' : (1) about fifty false killer whales (2) Three hours after casting a net, killer whale started follow our ship. Also damaged by sharks, (3) predator followed our boat for an hour at the right board. Species not identified..

Table 2. Data collection status on predation on commercial longlines by marine mammals and sharks

Country	Received by IOTC	Status	Precision	Fishery	Period	Coverage raising	National report	Estimated loss (species)	Program
Australia	no	not ready to be released	-	Tuna longliners	-	-	yes	-	-
UK	yes		Per set	Tuna longliners	2000-2003 (6 months)	3% not raised to entire fleet	yes	target species and bycatch	Observers
China	no	not ready to be released	-	Tuna longliners	-	-	yes	-	-
France (Reunion)	yes	-	Per set	Surface longliners	1997-2000	not raised to entire fleet	yes	Only SWO	Logbook Scientific cruises
India	yes	-	Per set	tuna experimental longliners	2001-2005	not raised to entire fleet	yes	target species and bycatch	Observers
Japan	No	Classified confidential	-	tuna longliners	2000-2007	-	yes		Observers
Kenya	no	not ready to be released	-	Artisanal Tuna longliner		-	yes		-
Mauritius	yes	-	Per set	Surface longliners	2002-2006	not raised to entire fleet	no	target species	Logbook
Soviet Union	no	not ready to be released		Longliners	-	-	yes	-	-
South Africa	yes	-	Per set	Tuna longline	2002-2007		yes	target species	Observers
Spain	no	not ready to be released		Surface longliners			yes		Observers
Taiwan,China	no	Classified confidential		Tuna longline			yes		Observers

(Note) Data submitted to Working Party will be retained by the Secretariat or made available for other analyses only with the permission of the source. They are subject to the rules of confidentiality specified by the Commission (resolution 98/02)

A1-02

Informal Review of Observer Data from the Australian Fishing Zone with regard to Depredation from Pelagic Longline Operations (Report).

Anthony DE FRIES[1], Jay HENDER[2] and Kevin McLOUGHLIN[2]

[1]Executive OfficerWestern Tuna and Billfish Fishery Management Advisory Committee,
27 Saltair Street Kings Beach QLD 4551 Australia
Phone/Fax +61 7 5499 6822, adefries@bigpond.net.au

[2]Fisheries Scientist, Bureau of Rural Sciences, GPO Box 858 Canberra ACT 2601 Australia
Phone: +61 2 6271 6658, Fax: +61 2 6272 3882
Jay.Hender@brs.gov.au, kevin.mcloughlin@brs.gov.au

A pilot observer program on Australian flagged longline vessels operating off Western Australia concluded in June 2006. Prior to this Australian observers monitored Japanese longline vessels operating in the AFZ under Bilateral Agreement. The scientific focus of both programs was to collect accurate information on fishing effort, target species, bycatch and interactions with protected species. Systematic information was collected on catch condition (including damage) however current codes for this field do not distinguish between damage caused by sharks, billfish or cetaceans. This report summarizes an examination of the generic damage data for landed catch in relation to non-standardized comments made by observers associated with these events. The authors make a number of suggestions for improving estimates of losses due to depredation by way of changes to observer data collection methodology.

A1-04

Interactions of cetaceans and sharks with the Reunion Island swordfish longline fishery in the Indian Ocean between 1997 and 2000.

François POISSON*, Corentin MARJOLET, Kim METE, Marc VANPOUILLE.
Délégation IFREMER de La Réunion, BP 60, rue Jean Bertho 97822 Le Port cedex
*current address : IOTC P.O Box1011, fishing port, Victoria, Mahé, Seychelles.

Pelagic longlining was first introduced to fish for swordfish in off Réunion Island (France) in the Indian Ocean in the early 1990s. As the fleet and fishing grounds expanded, fishermen recorded an increase in cetaceans pillaging bait as well as eating caught fish, especially target species. Ifremer conducted a survey financed by the European Union and Réunion local Councils to evaluate the interactions, to identify the cetacean species involved and to estimate the levels of predation. Two cetaceans; the false killer whale *Pseudorca crassidens* and the short-finned pilot whale *Globicephala macrorhynchus* are attracted to fishing gear to remove bait and eat fish from it. These species do not appear to be adversely affected by the Longline fishery (3 juveniles have been caught purely by accident and released alive). The damage can sometimes extend to gear as well.

Results indicated that an average of 4.3% (80 t) and 3.2% (60 t) of the annual swordfish catches were damaged respectively by cetaceans and by sharks between 1997 and 2000. In addition, in close collaboration with fishing industry, the effectiveness of pingers to reduce predation and the likely uptake and use of these devices by fishermen was tested. During four trips onboard domestic longline, 23 sets were completed with standard commercial longline gear and line equipped with pingers.

An analysis of swordfish catch rates showed that pingers had no repellent effect on target fish. The effectiveness of pingers to protect the line against cetaceans was not proved as the fishers showed little interest in continuing to use these devices.

While the effects of the depredation on the fishery in this study appeared not to be a major issue, worldwide interactions between marine mammals and fisheries represent a growing conservation issue. There is a need to improve our knowledge on the behavior, biology, hearing abilities, population size and migration pattern of these two alleged species which are poorly known in Indian Ocean.

Observations and data collection should continue in order to document changes, however a priority would be to standardise observer protocols in order to get a global picture in the Indian Ocean. Fishing industry, scientists, economists and decision makers must be involved in the future research plans.

A1-05

DEPREDATION IN THE TUNA LONG LINE FISHERY IN INDIAN WATERS

S.Varghese, Sijo.P.Varghese and V.S.Somvanshi
Fishery Survey of India
Mumbai, India

Depredation in the long line fishery continues to be a common and regular phenomenon in the Indian waters. An observation programme on the tuna predation was initiated by India from the year 1977 on the recommendation of the Scientific Committee of the IOTC that the member nations may collect and report the predation data on tuna long line catches. The present paper provides information on the depredation on fishes caught by the long line survey vessels of Fishery Survey of India (FSI) **Yellowfin** and **Matsya Vrushti** operating in the Arabian sea and **Blue Marlin** conducting survey in the seas around Andaman and Nicobar waters during the period from 2001 to 2005. The shark related average annual depredation on long line caught fishes in the Indian waters is found to be in the order of about 2.15%. How ever during the year 2004 in the Arabian sea, the depredation rate was as high as 14.29 %. Monthly observation further shows that maximum predation was reported during the month of July in both the regions. The important varieties of fishes affected by depredation are the tunas, sailfishes and sword fishes. The predation does not seem to be either species specific or area specific as far as the Indian waters are concerned. Although sharks constitute the highest percentage of the by-catch component of the tuna long line fishery in Indian waters there appears to be no direct relevance to the number of tunas damaged due to predation. The extent of damage is observed to be partial in some cases and total in certain cases.

There is no practice of using any mitigation device in the Indian tuna fishing sector. Introduction of acoustic devices in the tuna long line fishery could prove highly beneficial. The data furnished in the paper is exclusively collected from the survey vessels operated by FSI. Similar data from the commercial vessels are lacking or reported nil

A1-07

Status of tuna depredation in Kenya

Stephen Ndegwa and Okumu Makogola

With decreasing catches of demersal fish, tuna fishing in Kenya has increased in importance over time. Artisanal, sports fishing and industrial long lining are the main tuna exploitation methods experienced here. The peak season for both sports fishing and artisanal tuna fishery in Kenya is between November and March when the sea is calm and a lot of fishermen can venture outside the reef for their activity.

As fishing effort targeting the tuna stocks increases, the fishers have been encountering a lot of losses due to depredation of their catches mainly by the sharks and the killer whales. Both artisanal and sports fishing have mostly been affected by sharks. Depredation of the tuna is highest during the months of February and March which coincides with the high catches of sharks. However, although both the sports fishers and the artisanal fishers have been experiencing the loss of their catches, the artisanal fishers have been more affected than the sports fishers although they share the same fishing grounds.

Longline catches have mostly been affected by the killer whales. The only Kenyan registered long liner has not only been loosing the tuna catch but also the baits. According to the skipper of the long liner, bait loss to the killer whales has been as high as 75%. Tuna depredation for the long line is throughout the year and is experienced all over the Kenyan, Tanzanian and Madagascar waters where they have been fishing.

A remedy to this loss would be very welcome as the losses have sometimes been so huge that some players have been contemplating moving out of the business. This loss has seriously affected their profits and with the ever increasing fuel prices and reducing catch per unit effort, fishing has become a costly undertaking altogether. This workshop offers a good opportunity to address the plight of these fishermen and also address the unreported catch data due to depredation.

A1-09

Depredation by sharks and cetaceans on semi-industrial pelagic longliners targeting Swordfish in the Seychelles

[1,4]Rabearisoa N.', [1]Aumeeruddy R., [1]Dorizo, J., Vely M., [1]Giroux F., [3]Adam O., [4]Guinet C[*].,

1. Seychelles Fishing Authority, BP 449, Victoria, Seychelles

2. Ministère de l'environnement et des ressources naturelles. BP445. Victoria. Mahé. Seychelles

3. Laboratoire Lissi-iSnS, Bât P2, Université Paris 12, 61 av Général de Gaulle, 94010 Créteil cedex, France

4. CEBC-CNRS, 79 360 Villiers en Bois, France,

Depredation is defined as the damage or removal of fish from fishing gear by cetaceans or sharks. It occurs throughout the world and has been notably documented in several regions of the Indian Ocean. A database was built to assess its extent on the pelagic longline fishery of the Seychelles archipelago. Data were collected from pre-existing databases, fishermen's logbooks and location of fishing vessels from satellite data. Depredation involves short finned pilot whale (*Globicephala macrorhynchus*), false killer whale (*Pseudorca crassidens*) and pelagic sharks. Targeted fish include swordfish (*Xiphias gladius*) and tuna (*Tuna* spp.), but within the scope of this study we focused on swordfish, the main target species. Factors likely to influence depredation rate such as the length of the line, soak time, the period of the year, location and orientation of the line were investigated... The proportion of sets, with shark depredation was significantly greater than with cetacean (41% v.s. 16%). However when depredation occurred, mean number of damaged fish on the line by cetaceans (15.3 fish/1000 hook, i.e. 60 % of the fish caught) was higher than by sharks (3.8 fish/1000, i.e. 18 % of the fish). Data were analyzed using Generalized Linear Models. Shark depredation rate was negatively related to length of the line and increase from North to South. Both depredation rate by cetaceans and sharks occurred in areas or periods of higher Catch Per Unit of Effort suggesting the co-occurrence of shark and cetaceans in areas of high concentration of sword fish. No other factors were found to influence depredation rate, suggesting that no easy solutions are likely to be found by modifying the fishing practice and that further studies are requested to better understand the depredation process. Other solutions such as the protection of the fish caught on the line have to be investigated. The global depredation rate was 21% , representing 4.2 fish lost/1000 hook, and is one of the highest in the world. For sword fish only, we estimate that the economical loss is about 340 €/1000 hook set which represent an estimated loss of nearly 1,000,000 € over the 1995-2006 period.

A1-10

Killer whale depredation in the South African pelagic longline fishery

Samantha Petersen and Tony Williams

Killer whales are known to depredate on pelagic longline gear. A total of 1843 sets or 3.8 million hooks were observed in South African waters from January 2002 to March 2007 for killer whale depredation. A total of 689 killer whales sightings were recorded from 228 or 12.4% of sets observed. There was no trend evident between years or months, although less sightings were recorded during in April and May. Killer whale interactions with the pelagic longline fishery predominantly occurred on the Agulhas Bank and along the continental shelf towards Port Elizabeth. Pod size varied between 1 and 10 animals (mean=3.06, std dev=1.94). Depredation by killer whales resulted in the loss of 4.8 tuna or swordfish per set (n=116 sets).

A1-11

Depredation on pelagic longlines in the Indian Ocean: an analysis of the Soviet historical database (1961-1989) on tuna research

Evgeny V. ROMANOV*, Daniel GAERTNER, Pascal BACH, and Natal'ya ROMANOVA;

Unite de Recherche n° 109 (THETIS) IRD Centre de Recherche Halieutique Mediterraneenne et Tropicale;

Depredation on pelagic longline catch was studied from long-term data series (1961-1989) collected during Soviet research cruises in the Indian Ocean. Depredation was analysed for two principal groups of predators involved: cetaceans and sharks. Breakdown at a finer species resolution was impossible due to potential misidentification of predators sighted at sea or identified from the traces of damage. Depredation by billfish was not considered here since billfish attacked fish caught usually hooked and therefore treated as catch. From a total of 4142 sets with capture (positive sets) conducted during 91 cruises throughout Indian Ocean, 4588 individuals of 65 fish species/taxa were reported as depredated. Total average **d**amage **r**ate (DR, i.e. % of sets with recorded depredation to total number of operations) reached 28.0% of sets, with 3.95/1.11 damaged individuals per depredated set/per set. Overall de**p**redation **r**ate (PR, % of fish damaged to total number of fish caught) was 6.77. Yellowfin (*Thunnus albacares*), bigeye (*T. obesus*), albacore (*T. alalunga*) tuna and remains of unidentified large tuna (*Thunnus* sp.) comprised 83.6% of the total number of damaged fish (while these species represent 49.7% of the total number of capture including depredated fish). Sharks were responsible for 43.8% of depredation cases, cetaceans for 11.6%; the rest of damage (44.6%) was caused by unidentified predators. Spatial distribution of highest depredation level 'hot spots', long-term trends and seasonal variations in depredation level (overall and for target species) for both groups of predators are presented. The potential bias on tuna abundance indices (catch per unit effort) due to unreported information of depredation in longline fishery statistics is discussed.

A1-12

INTERACTION OF THE FALSE KILLER WHALE (*Pseudorca crassidens*) AND DEPREDATION ON THE SWORDFISH CATCHES OF THE SPANISH SURFACE LONGLINE FLEET WITH SPECIAL REFERENCE TO THE INDIAN OCEAN.

A. Ramos-Cartelle & J. Mejuto

On the basis of information provided by the fleet and by scientific observers during the 1992-2006 period, it was possible to identify the areas of interaction between the surface longline fishery and Pseudorca crassidens, the level of sporadic incidental bycatches of this cetacean and its depredation level carried out on the swordfish individuals caught by this fleet. In roughly 98% of the sets sampled by scientific observers, no depredation was detected on the swordfish and in only 2% there were signs evidencing depredation on the swordfish catches. According to on-board scientific observations, the incidental catch rate of the false killer whale was estimated to be 1.685 individuals per million hooks for the Indian ocean although the incidental mortality rate was null. The intertropical region of the three oceans presented the greatest interaction with the swordfish fishery, reaching in some of the areas a mean impact affecting over 10% of the catch in number. On the basis of mean predation rates by region and quarter, the average number of swordfish estimated to have been depredated by the false killer whale in 2005 would range from 509-2706 swordfish individuals in the Indian Ocean. These modest overall incidences are probably due to the recent fishing areas and fleet's effective practice of avoiding areas of major interaction with the false killer whale.

However, when attacks do occur, they can be devastating to the fishery interests of the vessel and may ruin their yields. Data from sets in different oceans with HPUE>0 indicate that predation usually amounts to less than 5 swordfish per thousand hooks, although, it may sporadically reach or exceed 20 fish. Sets having HPR>0 indicate that, when attacks occur, depredation may affect a number of swordfish equivalent to 50% or more of the catch held on board and may even damage the catch in a proportion that is several times greater than the number of swordfish retained on board. For general purposes it was estimated that in 2005 Peudorca crassidens carried out a mean overall depredation in the Spanish surface longline fleet of around 0.5-2.6% on the total number of swordfish caught in the Indian ocean.

A1-13

Some data of predation from the Pilot Action RAI-AP-08/2004 by two Spanish surface longline ships in South-western Indian Ocean during 2005

Ariz J.[1], A. Delgado de Molina[1], Mª L. Ramos[1], J.C. Santana[1]

[1] Centro Oceanográfico de Canarias
Instituto Español de Oceanografía
P.O. Box 1373
38080 Santa Cruz de Tenerife
Islas Canarias. Spain

According to the IOTC announcement of the workshop on the depredation in the tuna longline fisheries in the Indian Ocean, this document presents data about predation obtained during 2005 by scientific observers on board two Spanish surface longliners in waters of South-western Indian Ocean.

Data are analysed by groups of species, preys and predators. These groups of species predated are tuna, sharks, billfishes and other fishes. This report includes some non-commercial groups of species such as Family Alopiidae, *Pseudocarcharias kamoharai* and *Alepisaurus ferox*.

Analysing percentage of predation, in number of specimens and tons, as the relationship between the number or tons of fishes predated and total catches, it is observed that he main group of commercial species discarded owing to predation is tuna (3,66% of total catches, in number of specimens), followed by billfishes (2,55% of total catches, in number of specimens), other fishes (2,41%) and finally a low percentage of sharks and rays (0,07%); while the percentage of incidental catches predated is really no significative (0,02-0,05%).

The percentage of predators is around 78-79% for sharks over all the groups of species caught by the longline, adding a 3-4% of damage owing to *Isistius* sp. bites.

[1] Centro Oceanográfico de Canarias
Instituto Español de Oceanografía
P.O. Box 1373
38080 Santa Cruz de Tenerife
Islas Canarias. Spain

A1-14

Studies of the Tuna depredation of EEZ of Sri Lanka

J.A.D.B. Jayasooriya,
Fishery Statistician, Sri Lanka

This report summarizes experience and available knowledge on tuna fishery in Exclusive economic zone (EEZ) of Sri Lanka.

Inboard motorized boats (Multy day and Single day) and out board FRP boats carried out the tuna fishery in Sri Lanka. The total tuna catch in Sri Lanka was 100,000 tons in 2006. The civil disturbances and tsunami in 2004 affected to decline the catch.

Tuna catch rates are high in the south, south west coasts and south east coasts. Highest catch rates were reported for yellowfin tuna. The peak season for yellofin and skipjack is south west monsoon. No seasonal variation for yellowfin in south and west coats of Sri Lanka.

After tsunami in 2004, Tuna fishery in Sri Lanka has considerably changed from gill net to longline fishery. Length and weight data which are collected by NARA the research institute of Sri Lanka, used to analyze the average length.

Export of tuna to the sashimi market and the European market is increasing. The hygienic quality of tuna landing is becoming better to meet the international demand.

Low grade fish or especially skipjack tuna landing for dry fish or animal feed increased. No sufficient information was available to determine the proportion of the bycatch and the nominal catch.

A1-15

On the Sharks and Other Undesirable Species Caught by Tuna Longline

K. Sivasubramaniam
(Department of Fisheries, Faculty of Agriculture, University of Tokyo, Tokyo)

Records of Oceanographic Works In Japan Vol. 7, No. 1, March 1963

The study of undesirable species or those species other than tunas and spearfish caught by tuna longline would contribute to the knowledge of the community life in the tuna fishing grounds, the density, distribution of undesirable species and also the effect of these undesirable species on the catch of tunas and spearfish.

The results of the analyses showed that, (1) the undesirable species from 10% to 25% of the total catch, (2) *Carcharinus longimanus* and *C.brachyurus* are abundantly distributed in the yellowfin tuna fishing ground and similarly the *glyphis glauca* and *Isurus* species are distributed in the albacore, bluefin and bigeye tuna fishing grounds, (3) both seasonal and regional variation of the undesirable species composition depends on species of tuna abundance during those seasons and those areas, respectively, (4) the shark catch reaches a maximum after a certain length of soaking time as in the case of tuna catch and (5) the percentage of tunas damaged by sharks varies with season and region, however the percentage of tunas damaged by sharks appears to be higher in the yellowfin grounds than in the other types of tuna fishing grounds.

A1-16 & A1-17. No abstracts available

A1-16 Sivasubramaniam, K. Predation of tuna longline catches in the Indian Ocean, by killer-whales and sharks. Bull. Fish Res. Stn, Ceylon, Volume 17, Number 2 pp 221-236, Decenber, 194.

A1-17 Sivasubramaniam, K. New evidence on the distribution of predatory pelagic sharks in the tuna grounds of the Indian Ocean. Bull. Fish. Res. Stn., Ceylon Vol 20, pp 65-72, 1969.

A1-18

Depredation of fish caught on tuna longlines in the BIOT area.

J. Moir Clark, J. Roberts, C. Mees.

Marine Resources Assessment Group Ltd.
18 Queen St
London W1J 5PN
enquiries@mrag.co.uk

Data collected by observers operating on longliners in the BIOT Fisheries Conservation and Management Zone (FCMZ) since 1997 were analysed to determine the levels of depredation caused by sharks and whales. Since 2000 observers have been required to monitor all hooks hauled while on the vessel, recording the species and condition of the fish that are coming up (i.e. 100% hook coverage). Prior to this between 1997 and 1999 the condition of all fish were recorded as part of the biological sampling requirements (i.e. 100% fish coverage). In total 120,178 hooks were observed between 2000 and 2002 with a further 4,436 fish samples analysed between 1997 and 1998.

Information on levels of depredation were taken from the observer reports between 1997 and 2003, where the number of fish observed and the number of fish mutilated were recorded. Depredation levels for these years averaged at 6.44% for yellowfin tuna, 4.20% for swordfish and 1.98% for bigeye tuna. Some bycatch species were also mutilated including sailfish, lancetfish and blue sharks.

The majority of the depredation was caused by sharks, as identified by toothmarks in the mutilated fish and from anecdotal reports by the skipper and crew of the vessels. It was also reported that killer whales, false killer whales, pilot whales and dolphins were responsible for removing both bait and fish from the lines.

A1-19

Sperm Whale Depredation of Sablefish in Southeast Alaska.

Joe Liddle[1,2], Jan Straley[1,2]

[1] University of Alaska Southeast Sitka campus
[2] University of Alaska Fairbanks, School of Fisheries and Ocean Science

Sperm whales have learned to remove sablefish from long-line gear in Alaska. Concerns about economic losses and whale entanglement prompted a study of sperm whale depredation. We estimated the amount of fish consumed, described whale arrivals at the fishing gear and estimated sperm whale abundance.

We compared 124 long line sets, with and without sperm whales, and found that 2.83% of the fish were lost to sperm whale depredation. We fitted a repeated measures model to estimate whale counts dependent on stage of the set and month. Abundance was estimated with Bayesian mark-recapture method developed by the authors: $\hat{N} \cong 104$ and 95% credible interval (74,165).

These results are a part of the North Pacific Research Board study (R0309) to define the interactions between sperm whales and fishing vessels.

A1-22

Observation of predation occurred in the Chinese longline fishery in the tropical Pacific Ocean based on observer data

Xiao-jie Dai, Li-ming Song, Liu-xiong Xu,

College of Marine Science and Technology
Shanghai Fisheries University, 334 Jungpng Rd.
Shanghai 200090, P. R. China.

Based on the scientific observer data and some logbook data, the paper reported the predation observation in the longline fishery operated in the tropical Pacific Ocean. There are two types of predation, which resulted from dolphins(or whales) and sharks respectively, mostly from dolphins. The rate of predation in the total set was recorded,. Based on the appearance of hooked catch bited and damaged by predator, species of hooked catch were identified. The total catch of predation was estimated. Measures for mitigating predation from longline fishery were suggested.

A3-01

Review of the mitigation methods

Nishida (NRIFSF, Japan),
Ichimura* and Mohri (Shimonoseki Fisheries University, Japan)

*Based on the bachelor thesis(2003)

The mitigation methods for marine mammals are reviewed. There are four approaches, i.e., Operational, Population control, Chemical & Physical and Acoustical. In the operational approach, there are seven methods, (a) Escape, (b) Co-existence, (c) Decoy (agent provocateur), (d) No left-over foods, (e) Drift without lights, (f) Line alternations and (g) Deep setting. Based on the review, the most effective approaches at this stage are considered to be the combinations of the seven operational approaches. If in the future, the effective active acoustic device and/or the protected nets (one of the physical approaches) were developed, it is suggested to use them with the combined operational approach. The table below is the summary of this paper.

Summary (Effectiveness) O: good, Δ :less X: No

	Operational	Population Control	Chemical Physical	acoustical
Effective-ness	O, Δ or X	X	-Protected cover O(?) - Others X	- Small pinger X - Large & strong one O(?)
comment	- Consistent effectiveness are not expected. - Need to change alternatively	Not realistic	-Protected cover (net) (some hope)	-Signals with large, strong & changeable patterns may be effective.

A3-02

Mitigation of toothed whale depredation on the longline fishery in the eastern Australian Fishing Zone

Geoff McPherson[1], Craig McPherson[2], Phil Turner[2], Owen Kenny[2], Andrew Madry[3], Ian Bedwell[4], Doug Cato[5] and Dave Kreutz[6].

[1]Department of Primary Industries & Fisheries
[2]Electrical Engineering James Cook University
[3]Madry Technologies
[4]Thales Underwater Systems
[5]Defence Science and Technology Organisation and
[6]OceanWatch/SeaNet

In the Coral Sea, short-finned pilot whales and false killer whales were the main species responsible for depredation. This project evolved a dual mitigation strategy to ***avoid*** depredation on a broad scale, and to ***minimise*** the problem on a close-in scale.

To meet the ***avoidance*** objective, improvements in acoustic localisation of vocalising toothed whales were achieved. Two three-dimensional acoustic tracking systems developed to track the swimming trajectories around longline gear, one for echolocation clicks and one for whistles. The Madry Technologies Versamon software package featured the real-time capability to track whales with the capability of detection of the real-time bearings to sperm whales. The JCU Electrical Engineering 3DLOC software package featured the capability to track whistles in 2D and 3D and incorporated whistle isolation and enhancement to extend tracking range.

Oceanic acoustic propagation models were considered to assess the minimum standoff capability range required by fishing crews to achieve a workable avoidance strategy. A project recommendation is that radio direction finding buoys used to locate segments of longline gear should be fitted with acoustic sensors to detect the presence of vocalising toothed whales within a preset radius and transmit the information to the vessel in order that the skipper could take appropriate action to ***avoid*** depredation.

To meet the ***minimisation*** objectives, active and passive acoustic mitigation methods were trialled. Various active acoustic systems evoked a range of reactions, however even when aversive responses were observed the range was far too short for commercial longline use. Some systems demonstrated potential to reduce interactions with other species in different fisheries.

A passive acoustic depredation mitigation device based on combinations of fishing gear components with acoustic reflection capability showed most potential. The project device was as much a visible deterrent to depredation as it was a reflector of toothed whale echolocation clicks designed to confound the acoustic perception of the target. Depredation will not be reduced in longline fisheries by workshops that repeatedly discuss the same issues. Specific research to investigate the mechanism and detection of depredation, and the toothed whale capability for vessel of fishing gear detection is still required. Logistical aspects of depredation detection are being pursued by industry (Clarke *et al*., this workshop), as institutional support is often lacking. This research was supported by Australia's Fisheries Research and Development Corporation.

There will always be some risk, real and perceived, to marine mammals that interact with fishing gear during depredation events. Risks to depredating toothed whales should be minimised but should also be considered in the light of population enhancements due to depredation.

A3-03

An option for long range acoustic detection of toothed whale depredation on longlines.

Gary Clarke[1], Geoff McPherson[2], and Dave Kreutz[3].

[1]RSM Systems,
[2]DPI&F and
[3]OceanWatch/SeaNet

Localisation of toothed whales responsible for longline depredation would assist the longline fishing sector to identify the presence or general location of vocalising toothed whales in oceanic conditions. Knowledge of the location of toothed whale herds would permit fishing crews to make informed fishing decisions to *avoid* toothed whales prior to setting gear, or to *avoid* the losses due to depredation when toothed whales encountered longline captured fish.

An acoustic sensor system is proposed as the most cost-effective option to detect vocalising toothed whales at maximum ranges to avoid depredation. The sonobuoy-type system would utilise a hydrophone acting as an omni-directional proximity detector. Output of acoustically distinctive whistles generated by depredating toothed whales would be collected then encoded to a narrow frequency bandwidth and transmitted using existing radiolocation buoys. The transmission range will be the same as the existing buoys which could be moored or drifting, to allow for the detection of toothed whales over a wide area.

To this end, RSM Systems (Sydney) has commenced design options to incorporate a hydrophone and acoustic electronics module into an existing radio buoy, to operate over its radio transmitter. The hydrophone will be suspended below the buoy and connected to an acoustic module positioned inside the buoy which will convert the acoustic data for transmission using the existing RF transmission system. There are substantive electronic reasons why the signals should be transmitted as the simple presence / absence of vocalisations around a buoy rather than transmission of the entire whistle frequency range.

RSM Systems is considering the most cost-effective method of displaying the presence/absence of toothed whale vocalisations around the radio beacons, either by utilising existing hardware associated with the beacons or as a small stand-alone indicator. The use of existing equipment would simplify the process for vessel's crew and ensure no operational changes are required.

Where multiple herds were vocalising in a region, manual detection systems would not be appropriate for a fishing vessel. Semi-automated signal isolation and enhancement software (such as McPherson *et al.*, this workshop) would be increase the proximity detection range.

CONTACT: gclarke@rsm-systems.com

A3-04

Development Of Passive Acoustic Tracking Systems To Investigate Toothed Whale Interactions With Fishing Gear.

Geoffrey R. McPherson(1)*, Chris Clague(1), Phillip Turner(2), Craig R. McPherson(2), Andrew Madry(3), Ian Bedwell(4) and Douglas H. Cato(5).

(1) Queensland Fisheries Service, DPI&F, PO Box 5396, Cairns, QLD, Australia

(2) School of Electrical Engineering, James Cook University, Townsville, QLD, Australia

(3) Madry Technologies Pty Ltd, PO Box 1269, Castle Hill, Sydney, NSW, Australia

(4) Thales Underwater Systems, 274 Victoria Rd, Rydalmere, Sydney, NSW, Australia

(5) Defence Science and Technology Organisation, PO Box 44, Pyrmont, Sydney, NSW, Australia

Depredation (=stealing) by toothed whale species of Coral Sea tuna longline catches threatens the viability of the fishery through direct removal of bait and hooked fish and behavioural modification of the target fish species. The false killer whales and short-finned pilot whales responsible for depredation on longline catches generate frequency modulated communication whistles, time constant broadband burst-pulses with a possible emotional context, and time variable broadband echolocation trains used in hunting. All vocalisations offer potential for passive acoustic tracking. A range of methods is being developed to mitigate depredation including acoustic, mechanical and chemical approaches. To assess the effectiveness of these methods, an integrated passive acoustic tracking system to determine movement trajectories of toothed whales relative to longline gear is under development for use in oceanic situations. A real-time tracking system for broadband clicks using a small aperture Mills Cross array to obtain an initial azimuth to source, is being integrated with a post-processing, wide aperture sonobuoy system for all vocalisations to obtain localisation in three dimensions. Data obtained from the small aperture array showed that comparable azimuth estimates were obtained for inshore toothed whales using both tracking systems. Trials over wide areas in oceanic conditions with larger arrays (1.5-1,000 m) to determine 3 dimensional trajectories, are yet to commence.

A3-07

On the invention of effective and perspective device (protected net) for the mitigation of depredation of fishes in longline fisheries

Leonid K. PSHENICHNOV
Aleksandr K. ZAITSEV
Southern Scientific Research Institute of Marine
Fisheries and Oceanography (YugNIRO)
2 Sverdlov str., Kerch 98300 UKRAINE
E-mail: lkp@bikent.net

Abstract

Sizeable damage for longline fisheries in the World Ocean inflict on eating away caught fishes by sperm-whales and killer-whales. Aboard commercial longliner that fished Patagonian toothfish with modified bottom Spanish type longline for the first time was applied device for mitigation of interaction of caught fishes with marine mammals.

Fishing for toothfish carried out in South-West Atlantic Ocean out of EEZ bordered countries on depths 750-1900 m. At fishing time constantly some sperm-whales (2-5) were near vessel. After each hauling observed some dozens of damaged fishes or fishes with eaten away trunks (sometimes it was about 50% of total catch).

For prevention of depredation of catch in second half of trip applied special device. Used kapron net, which closes hooks with caught fish at time of hauling. At time of fishing net not hinder to contact fish with bait. While at time of hauling net covers of hooks and prevent contact mammals with caught fishes. After beginning of using of protected nets damaged or depredation of fishes not observed.

Key words: longline fisheries, sperm-whales, protected nets.

A4-01

Ecological interactions between fisheries and marine mammals in the Indian Ocean: Do whales and fisheries compete for resources?

Nick Gales
Leader, Australian Centre for Applied Marine Mammal Science
Australian Antarctic Division
Channel Highway, Kingston
Tasmania 7050

Whales have the potential to interact with fisheries directly (e.g. bycatch and depredation) and indirectly (e.g. competition for a shared resource). While mitigating the direct interactions represent substantial challenges for fishery management, given adequate resources they are relatively easy to quantify and understand. The indirect, ecological interactions are vastly more difficult to measure and understand, primarily due to the complexity and dynamics of marine food webs and ecosystems.

Attempts to understand these ecological interactions have been developed using data on diet and with models that attempt to simplify the workings of ecosystems. However these models cannot yet accommodate the complexity of the systems nor deal with the uncertainty that arises from our imperfect knowledge.

While science attempts to better model marine ecosystems, a number of hypotheses and model outputs have been proposed and are being represented in some forums as being sufficiently robust that management should respond to them. Among these are suggestions that consumption by whale populations is directly limiting fishery yields. Evidence for this is based on whales and fisheries targeting a common prey, and modelling the interactions between the fishery, the whales and the shared prey.

In this paper I discuss the relationship between ecological competition and the simple circumstances of feeding on (or fishing for) a common prey. I also discuss the spatial and temporal aspects of consumption by cetaceans in the Indian Ocean and investigate the plausibility of ecological competition occurring with fisheries. The conclusions clearly demonstrate that ecological competition between whales and fisheries in the Indian Ocean is highly unlikely, and that if it occurs at all, it does so at transient and highly localised scales. Scientists, managers and fishermen who deal with interactions between cetaceans and fisheries should rather focus on the more important and influential direct interactions such as bycatch and depredation

A4-02

Fine scale behavioral and underwater video observations of sperm whales near longline fishing vessels in the Gulf of Alaska and recommended deterrents to avoid depredation

Straley, Janice[1]; Thode, Aaron[2]; Folkert, Kendall[3]; O'Connell, Victoria[4]; Behnken, Linda[5]; Mesnick, Sarah[6] and Liddle, Joe[1]

(1) University of Alaska Southeast Sitka Campus , 1332 Seward Ave., Sitka, AK, 99835, USA

(2) Marine Physical Laboratory, Scripps Institution of Oceanography, San Diego, CA, 92093-0205, USA

(3) F/V Cobra, PO Box 6497, Sitka, AK, 99835, USA

(4) Coastal Marine Research, 107 Finn Alley., Sitka, AK, 99835, USA

(5) Alaska Longline Fishermen's Association, PO Box 1229, Sitka, AK, 99835, USA

(6) Southwest Fisheries Science Center, NOAA Fisheries, La Jolla, CA, 92037, USA

A study among fishermen, scientists and managers collected data on depredation of sablefish (*Anoplopoma fimbria*) demersal longlines by sperm whales (*Physeter macrocephalus*) in the Gulf of Alaska, 2003-2007. The goals were to characterize the whales involved, determine the mechanics of depredation, and recommend changes in fishing behavior to reduce depredation. At sets when whales were present (N=39), 71% had evidence of depredation. Genetics determined the whales (N=19) were male. Bayesian mark-recapture analysis estimated 123 (94, 174; 95% credible interval) whales in the study area. Passive acoustic recorders permitted monitoring of the underwater noise environment, including sperm whale activity, before and during longline recovery. We found engine cavitation noise is correlated with changes in acoustic activity of sperm whales, while vessel hydraulics or cable strum was not. We tested three passive deterrents: decoy anchorlines, hydrophones for passive acoustic monitoring and minimizing engine cycling during the haul. We determined fewer interactions occurred and whales were less likely to follow vessels using one or more of these strategies. To observe how animals remove individual fish, an underwater video camera was attached to a longline that had been partially hauled and then lowered between depths of 90m and 120 m, with sablefish attached 2-4 m above the camera. Hydrophones were deployed at 17 m depth during the 40-60 minute deployments, and mounted 1.3 m below the camera. During two encounters, one whale investigated the line, producing characteristic "creak" sounds that were recorded on the three hydrophones, and which were subsequently time-aligned using vessel noise in order to permit acoustic tracking. A second whale interacted with two fish within 4 m of the camera, but only the camera hydrophone was available. Acoustic analyses shows maximum click production rate is 33clicks/second and echolocation is used by sperm whales to target prey.

A4-03

Best Practices for the Collection of Longline Data to Facilitate Research and Analysis to Reduce Bycatch of Protected Species

Dietrich, K., V.R. Cornish, K.S. Rivera, T.A. Conant. 2007.

Report of a workshop held at the International Fisheries Observer Conference, Sydney, Australia, Nov. 8, 2004. U.S.Dep. Comm., NOAA Technical Memorandum NMFS-OPR-35; 88 p.

Workshops focusing specifically on the reduction of sea turtle, marine mammal, and seabird incidental catch (i.e., bycatch) in longline fisheries have recommended the need for standardized data collection procedures employed by fisheries observers onboard commercial longline fishing vessels. However, these reports lack sufficient detail regarding what these standardized data collections should be. To facilitate research and analysis of factors influencing bycatch of marine mammals, sea turtles, and seabirds in longline fisheries, a workshop was organized to develop "best practices" in observer data collections. The workshop was held in conjunction with the International Fisheries Observer Conference, November 8-11, 2004, in Sydney, Australia.

The objectives of the workshop were to share and solicit information, coordinate with observer program staff, recommend best practices for observer data collection in longline fisheries, and establish a network to continue to develop, refine, and implement best practices.

Prior to the workshop, two web-based surveys were developed and distributed to observer program managers and data users worldwide. The objectives of the survey were to ensure broad input from researchers and observer program staff who may not be able to attend the workshop, and to provide a base of information from which to focus discussions during the workshop. At the workshop, participants discussed the results of the surveys and need to develop best practices for observer data collections.

Critical and preferred variables were identified, based on the responses provided by data users in the pre-workshop survey and discussions by workshop participants. This list of variables represents "best practices" that should be included in the collection of longline data by fisheries observers. Optimal data specific to bycatch species was also identified and included a recommendation for collecting evidence of depredation on catch (by marine mammals or other species), including species of fish damaged, description of type of damage, photographs of damaged fish, and number of fish damaged.

Workshop participants also made recommendations for observer programs to consider when incorporating these best practices into observer data collections.

The full report is available at http://www.fakr.noaa.gov/protectedresources/seabirds/llreport0307.pdf