International Seafood Sustainability Foundation

Third meeting of the scientific committee of the ISSF Bycatch Mitigation project

Montpellier, France - 14, 20, 21 October 2012

Fifteen participants attended the third annual meeting of the bycatch committee which was held in Montpellier before and after the symposium entitled "EBFM 2012: Towards ecosystem-based management of tuna fisheries". Some results summarized in this report were presented at the symposium.
Two members of the bycatch committee were unable to attend this meeting, Martin Hall and Javier Ariz. The objectives of this meeting were 1) to review the activities conducted under the project during the past year and 2) to identify the research priorities for the future. The report is structured in three parts: activities conducted since September 2011, research priorities and recommended practices. This last section aims at emphasizing the results that can already be used to reduce bycatch by purse seine vessels.

Participants to the 3rd meeting of the ISSF Bycatch Committee

1 Activities conducted since September 2011

Activities presented in this report include those conducted under the ISSF bycatch project as well as other projects on bycatch mitigation in tuna purse seine fisheries, e.g. MADE, Japanese bycatch project, Orthongel, etc.

1.1 Developing best practices for handling elasmobranch and turtles

A guide was produced by MADE and Orthongel, which has been incorporated in the ISSF skippers guidebook to sustainable fishing practices.

1.2 Post release survival of silky sharks from purse seine vessels

Post release survival of silky sharks captured during purse seine fishing operations was assessed during cruises in the WCPO and IO (in addition to results obtained in 2011). Results from all three oceans (2011 and 2012) showed that when the best handling practices are followed, the overall survival rate of all captured sharks released from the deck ranges between 10 – 20%.
Survival studies of silky sharks indicate a strong correlation between survival and the point during net retrieval at which the sharks are released. Sharks released prior to brailing and those superficially tangled in the net have high survival rates, those released from the first brail have a moderate chance of survival. After the first brail shark survival is low.

1.3 Behaviour of fish in the net

Multiple underwater observations of target and bycatch species within the net were made during the WCPO cruise. Results showed that both species and size segregation occurs inside the net during the hauling process. Within the target species, the tunas were observed to segregate by size and species, with larger individuals of YFT and BET typically occupying the deepest portion of the net while small YFT and BET were most often near the surface. SKJ were regularly observed to school in the middle, between these two groups. Sharks and some other teleost bycatch were regularly observed to form aggregations near the surface and close to the net, at the furthest point from the vessel. These promising results prompted the committee to identify this line of research (the predictable location of bycatch within the net) as an area of priority for future cruises. This information was used to design and test an escape panel during the second leg of the WCPO cruise but the committee felt that much more extensive testing should be conducted and that some additional modifications (such as the exact location of the escape panel) should be evaluated. The committee also placed high priority on research that would determine if the behaviour of shark bycatch observed in the WCPO also occurs in other regions and other oceans.

1.4 Live removal of encircled sharks

- Trials to attract sharks and other bycatch out of the net by towing the FAD out at the bow or stern were conducted during both IO and WCPO cruises. Results indicate that this approach showed no potential as an effective practice.
- Following observations made during the IO cruise, an escape panel was proposed which would utilise the "natural" drift of the FAD to lead the bycatch out of the net. The skipper and the scientists proposed a 15 x 15 m panel at surface located in the middle of the net, through which the FAD could be gently guided using the speedboat. Observations of fishers and scientists indicated that rapid changes in

speed or direction of the raft tended to disperse the bycatch aggregated under the raft, hence the need for minimal perturbation. The "natural" passage of the raft out of the far end of the net could be further enhanced by the force of the skiff and bow thrusters moving the PS vessel through the water. This proposal was well received by the majority of French skippers in attendance at the ISSF skippers workshops held after the IO cruise.

- Observations in the net by scuba divers during the WCPO cruise lead to the proposal and development of an escape panel close to the sack, through which encircled sharks become aggregated in the 'bend' of the net by passive action of the drift of the vessel. Trials using this panel showed promise (two sharks escaped and dozens remained at the entrance of the panel) but further experiments are clearly required. Increasing the number of replications under various environmental conditions was recommended as the success of this method may depend on environmental conditions. Furthermore, it was felt that modifications to the exact location of the panel (closer to the sack) should be tested in the future as well as the inclusion of various stimuli to improve the motivation for the sharks to move out of the net.
- In situ observation at late stages of the sacking up process revealed that the use of a hand scoop or skimming scoop with the brailer held little promise as a means to remove live or viable bycatch from the net.

1.5 Natural behaviour at FADs

Target and non-target species were tagged with ultrasonic transmitters together at multiple FADs in the IO (MADE and ISSF). The data obtained from these ultrasonic telemetry experiments were used to assess the optimisation of fishing time, in addition to improving our fundamental knowledge on the behaviour of these species at FADs. Two temporal patterns were observed with triggerfish and rainbow runners in close proximity to FADs at night while tunas and sharks were more closely associated during the day. As such, there appears to be no particular time of day that would reduce the capture of sharks while maintaining a sufficient tuna catch. In addition, the information collected on the vertical distribution of target and non-target species showed that all species occupy depths that are within the depth range of tuna purse seine nets. Consequently, the avoidance of capture of non-target species by standard purse seine fishing practices does not appear to be possible through the exploitation of natural horizontal and vertical distributions. The only caveat to this may involve the evasive abilities of medium to larger size bigeye tuna at dawn. It was recommended that further studies should attempt to describe the vertical behaviour of larger sized bigeye and yellowfin during the process of setting the net. This objective could be met by tagging target species with depth sensitive transmitters prior to the PS set. This pre-set tagging protocol has been successfully accomplished on previous cruises.

1.6 Echo-sounder buoys

Data from echo-sounder buoys in the IO were analysed and interpreted using data from target and non-target species tagged with ultrasonic transmitters. Validation of echo-sounder buoy data using catches at FADs is on-going from data supplied by the Spanish fleet in the AO. The limitations of the current buoy technology were highlighted along with the need for further catch validation and in situ tagging experiments in the future. The value of direct side-by-side comparison of different echo-sounder buoys (different companies) was also noted for future cruises.

1.7 Catch prediction estimates

Assessments of pre-set information were collected during both the IO and WCPO cruises. In both instances the estimates of total catch were relatively accurate but species composition estimates were not provided. This was largely attributed to the fact that both skippers had little knowledge on how to fully utilize acoustic equipment available onboard their vessels. Furthermore, the lack of incentives required to develop such skills was identified as the primary reason behind this lack of knowledge or lack of desire to refine their knowledge.

1.8 Double FADs and underwater lights

Two pure double FAD experiments were conducted during the IO cruise and the results presented during the meeting. Some species showed potential to segregate completely between the two FADs. A study using underwater lights indicated differential reaction of steady vs flashing lights between skipjack and bigeye tuna, suggesting a promising area of further research. It was noted that identifying unique or specialized physiological abilities of bigeye tuna may be a key avenue for identifying ways to separate the species from desirable catch.

1.9 Non-entangling and bio-degradable FADs

Estimates were provided for the non-observed mortality of sharks entangled in FADs in the IO and indicated that this is a significant source of mortality in this region, probably exceeding the direct purse seine fishery mortality. This information was obtained from underwater inspection of FADs as well as from tagging data (miniPATs). The need for eliminating FAD designs that include net appendages of large mesh size suspended beneath FADs was highlighted as a very important priority. The committee identified these entanglement findings as one of the major accomplishments of the research effort and recommended that similar assays be carried out in other areas.

The problem of drifting FADs encountering islands and coral reefs was discussed and noted to be much more significant when non-biodegradable materials such as nylon netting and rope are used in the FAD construction. It was not considered that bio-degradable FADs would develop immediately but it was considered desirable to promote and work towards the use of bio-degradable materials by all fleets.

1.10 Underwater visual census (UVC)

In addition to documenting entanglement of marine organisms in FADs, diving activities at FADs provided the opportunity to conduct UVC where information on the species composition of aggregated bycatch species (biodiversity) was collected.

1.11 Fish pumps

After reviewing the findings of the investigatory trip to Northern Europe by Martin Hall, Jacques Sacchi, Tatsuki Oshima, Jefferson Murua and Tito, the committee agreed that this is currently not considered a feasible solution for bycatch mitigation considering:

- Tunas and sharks require ram gill ventilation and thus need to be able to continuously swim to survive, which would require the net not be sacked up. With small tunas and sharks swimming around in the net it would not be possible to expect to be able to extract them with the hose of the pump as their densities would be low and they would avoid capture.
- The fragility of the skin and eyes of tropical tunas and the high potential for post-release mortality of tunas forced through a rigid pump system.
- Even though some bycatch species (e.g. triggerfish, rainbow runners) are considered more robust than tunas (therefore with the potential of surviving being pumped) the testing of the effects of existing practices (brailing) on their post release survival should be a priority before investigating an entirely new approach for bringing the catch onboard. Currently the survival of these species has not been a priority.
- The density of fish required in the net. The likelihood of a shark surviving in the sack beyond this point would not differ from the current practices.

However the great potential for detailed catch monitoring (counting/identifying each fish with automated camera systems) of this system was noted. Furthermore it was felt that if the industry practices shifted towards utilizing such equipment, only then would the committee reassess to address the optimisation of this method for bycatch mitigation.

1.12 Sorting grids

After a problem with the local shrimp fishery the government of Ecuador has decided to postpone experiments on different types of sorting grids. However, the monitoring of the tuna purse seine fishery in the eastern Pacific continues, and the proposal to conduct statistical analyses on the observer data still holds.

1.13 Targeting bigger schools at FADs

The results of a desktop study (MADE), using observer data from all oceans, were presented showing large potential for reducing bycatch through the avoidance of capturing small aggregations of tunas at FADs. The work was published in the Canadian Journal of Fisheries and Aquatic Sciences:

Dagorn L, Filmalter JD, Forget F, Amande MJ, Hall MA, Williams P, Murua H, Ariz J, Chavance P, Bez N. 2012. Targeting bigger schools can reduce ecosystem impacts of fisheries. *Canadian Journal of Fisheries and Aquatic Science*. **69**: 1463-1467.

1.14 Electronic monitoring systems

- Experiments were conducted during seven cruises, including 3 in the AO, 2 in the IO and 2 in the WCPO.
- Data analysis from the AO has been completed by AZTI and showed good results regarding the estimation of total catch, the capture of large bycatch species and the ability to discriminate between FAD and unassociated sets. Detailed information on species composition and small bycatch species (including small sharks) was poor due largely to low image quality.
- Data from the IO cruises are still being analysed by IRD.
- Results from the seven cruises will be presented at an international conference in Chile in 2013.

1.15 Skippers workshops

Skippers workshops initiated in 2010 continued during 2012, with the most recent being held in Ecuador, the Philippines and Indonesia. Further workshops are to be held in Spain in the near future.

2 Research Priorities

2.1 Non–entangling FADs

The assessment of shark and turtle entanglement in FADs in each ocean is important to document the extent of the problem in different areas, and furthermore to allow for improved shark stock assessments. Such quantification could be performed using various methods:

- Underwater visual inspections of FADs (considered the optimal strategy), as it was done in the IO. This could be accomplished by snorkelling, by "look box" or by "dip camera" (easier protocol), but animals entangled in the deeper parts of the net might then be missed.
- Historical and current observations made by observers when the FAD was removed from the water by the PS vessel (not simply when a FAD was visited, as observers cannot observe organisms entangled below the surface)
- Estimates on the probability of sharks becoming entangled in other oceans could be obtained through the deployment of miniPATs on silky sharks, as performed in the IO, but this method implies high costs

2.2 Acoustic selectivity

Two key aspects were identified that concern future work with echo-sounder buoys:

- Improving the interpretation of acoustic data from existing buoys through 1) acoustic tagging experiments and 2) validating species composition and quantities within sets.
- Improving the buoy technology for better species identification

Future activities regarding the use of shipboard acoustic equipment include:

- The need for improving the skippers' knowledge of acoustic instruments. Training of skippers by technicians from manufacturers together with scientists is to be trialled on selected vessels (e.g. Spanish) in areas of the WCPO where BET catches are known to be significant, thus taking maximal advantage of the available technology. This could include improvements in the use of echosounders mounted on lightboats/workboats, and in particular results from the Japanese study investigating information collected from such echosounders.
- Developing incentives for skippers to improve their pre-set estimations through the use of a competition approach with prizes.
- The building of a library of echosounder images with corresponding catches was discussed, but several limitations were expressed (e.g. the need to know the type of echosounder and the settings during the recording of each image).
- The use of drop cameras used in the same aggregation being observed on echo-sounder is a viable way to confirm acoustic signatures in real time and can be incorporated into various experiments and the building of verified acoustic libraries.

2.3 Escape panels in the net

Two variations of the concept of escape panel were discussed and the testing of these was set as a priority for future research efforts.

2.3.1 Drifting FAD escape panel

- A meeting between a net specialist and an experienced skipper proposed simple modifications to the net that could allow the FAD to drift out "naturally" early in the set.
- This experiment was recognised to be specific to areas where FADs with short underwater appendages are common - e.g. IO.

2.3.2 Use of area in the net where sharks naturally aggregate

- Future cruises in the WCPO on the Cape Finisterre (TriMarine) with the current panel in place would be optimal for increasing the current sample size.
- Different locations of this panel should be be tested. In fact, more than one panel could be included in the same net in order to maximize experimental flexibility. This possibility exists because the first WCPO cruise indicated that the escape panel ran smoothly through the power block - a significant finding.
- Future experiments should include the pulling of the PS vessel by the skiff in a semi back-down manoeuvre. Intensified chumming during this time and the addition of white panelling around the window to optimize its visibility to the sharks could also be tested.

- The occurrence of the recognised accumulation of sharks in the 'bend' should be quantified (video) in all oceans and under differing environmental conditions. This can be easily done with HD video equipment either from small boats or ideally with skin divers supported by a small boat.
- Fundamental research on vision and the use of other stimuli was identified as a priority to optimise this practical approach.

2.4 Observations of fish behaviour in the PS net and in sea cages

- The results from the WCPO cruise showed promising potential for species segregation and selective release from the net and the committee recognised the requirement for this to be a research priority in the future. The collection of further in situ observations in the net was recognised as an immediate priority for any research cruise in the future.
- The use of a sea-cage (where a FAD aggregation could be transferred) would enable longer observations and would facilitate experimentations to identify stimuli that could enhance species segregation.

2.5 Depth of material beneath FADs

A statistical expert at the IATTC (Cleridy Lennert-Cody) will conduct in 2013 an analysis of EPO observer data from 2006 to current of various factors including spatial aspects, vessel and net characteristics, type of floating object, depths of materials suspended under FADs, and catch composition within sets to evaluate which characteristics are the strongest determinants of bigeye tuna catch and if depths of materials suspended beneath FADs is a significant factor. If appropriate data is available for other ocean areas similar type analyses should be undertaken. Depending on the outcome of the study in the EPO a large-scale experiment may be proposed to be undertaken in the EPO for evaluating bigeye catch associated with FADs with different configurations of materials suspended beneath and/or no materials suspeneded beneath.

2.6 Flat brailing

This brailing technique is currently used by some Japanese and Korean vessels to maximise catch quality as it scoops live tuna before they are restricted in the sack and exposed to excessive pressure in the sack and conventional brail. Two future activities were proposed:

- A desktop study assessing the numbers of live vs dead sharks onboard, from data collected by WCPFC observers
- Study the survival of released animals (sharks) brailed in this manner, using survival PATs or miniPATs.

2.7 Acoustic tagging of small and large BET and other species

- The need to continue the tagging of target and non-target species was recognised. Specifically the lack of information on the vertical behaviour of medium and large BET at FADs was highlighted. Behavior during the act of setting the PS net is of particular interest.

- The need to monitor this behaviour at FADs under natural conditions (e.g. for echosounder buoy validation or optimising set times) but also during setting to observe any potential change of behaviour during setting.

2.8 Competition between stimuli

It was recognised that the use of competing stimuli could have some significant potential to segregate the various species before or during setting. Below is a list of different experimental approaches that should be tested:

- Pure double FAD (two identical FADs, with similar length appendages). This option holds the potential of giving insight into the basic mechanisms of aggregation behaviour in tuna and, as such, also could have direct impact on future stock assessment models.
- Asymmetrical double FAD (differing depths of appendages, or no appendages)
- Experimental light in PS net (towing light, to move BET)
- Anchored FADs and light boats (a desktop study from observer data monitoring catch composition could provide useful insights)
- Drifting FAD with different stimuli (e.g. chemical, sound) and the light boat

2.9 Skippers workshops

- Each year the content of the ISSF presentations have been adapted and this trend should continue into the coming year. The new version should adopt a uniform (in all regions) and concise presentation format with a focus on results and recommendations obtained thus far while allowing times for interactive discussion and input from the fishers.
- Further outreach opportunities should be explored: extending to observers, fleet managers, owners, manufacturers, gear technologists.

2.10 Fundamental research

Conducting fundamental research was recognised as a high priority to optimise the development of practical mitigation measures. This area fosters the development of new ideas by opening currently unexplored paths to bycatch mitigation. Areas identified for immediate research include:

- schooling behaviour (e.g., “double FAD” experiments)
- vision of target and non-target species
- hearing of target and non-target species
- recording sounds at FADs
- colonisation processes at FADs
- Body condition and feeding success of tuna at logs and FADs

2.11 Assess impacts of fishing on the ecosystem

Improving our understanding of this area is essential for the identification of realistic targets for mitigation research, including assessments of abandoned FADs on reefs, the consequences of large scale FAD deployments on the

behaviour and biology of target and non-target species, obtaining the basic biological parameters of species that are currently of low concern.

2.12 Cruises

Activities that can be conducted during regular fishing cruises or under semi-charter agreements will be prioritized for 2013. Optimizing the collection of data through any cruises that are already planned on different vessels in all regions should also be prioritized.

3 Recommended practices

While further research is clearly required, some practices can already be recommended to reduce the incidental capture of non-target species (in particular for silky sharks) by purse seiners:

3.1 Non-entangling environmentally friendly FADs

- Considering the magnitude of the issue with entanglement of sharks observed in the IO, the committee recommends that the use of non-entangling biodegradable FADs be set as a commitment by all fleets.
- The appearance of the current ISSF guideline should be modified such that the optimal criteria for non-entangling and environmentally friendly (biodegradable) FADs is highlighted. This could be achieved by placing these points on a single page, such that it is obvious that the secondary list for the transition period is really the sub-optimal approach.
- The results of the IO study should be disseminated to other oceans through RFMO meetings.

3.2 Avoiding setting on small schools at FADs

For example, avoiding schools of less than 10 tons at FADs could reduce bycatch from 23% to 43%, depending on the ocean. For silky sharks, the reduction could vary from 21% to 41%, depending on the ocean. This could be proposed as a voluntary tool, not a regulation.

3.3 Best handling practices (elasmobranchs and turtles)

These practices are already in the ISSF guide.
The committee recommends that fishers expend maximum effort on the release of sharks caught in the first brails. This emphasis on early release would yield the greatest benefit per effort expended by the crew.

Annex 1: List of participants

Participant	Institute, Country
Laurent Dagorn	IRD, France
Gala Moreno	AZTI, Spain
David Itano	NMFS, USA
Kim Holland	UH, USA
Kurt Schaefer	IATTC, USA
Diego Bernal	UMASSD, USA
Rich Brill	NMFS, USA
Jacques Sacchi	France
Tatsuki Oshima	JAMARC, Japan
Peter Sharples	SPC, New Caledonia
Susan Jackson	ISSF
Victor Restrepo	ISSF
Francesca Forrestal	ISSF
John Filmalter	IRD, South Africa
Fabien Forget	IRD, Mauritius