FINAL DRAFT 3

Inter-American Tropical Tuna Commission

PURSE-SEINE BYCATCH WORKING GROUP

1st Meeting, 8-9 July, 1998
La Jolla, California, USA

CHAIRMAN'S REPORT

1. Welcome, introductions, and consideration of agenda

The first meeting of the Purse-Seine Bycatch Working Group was held at the Southwest Fisheries Science Center, La Jolla, California on 8-9 July, 1998. The Chairman, Dr Robin Allen, Assistant Director of the IATTC, welcomed the participants, and noted that they were invited in their individual capacities as experts and not as representatives of countries or institutions. A list of the participants is attached as Annex 1, and the agenda as Annex 2.

2. Introduction

The Chairman gave a general introduction to the tuna purse-seine fishery of the eastern Pacific Ocean (EPO). He noted that one of the side effects of attempting to find ways to reduce the incidental mortality of dolphins in the fishery was a greater emphasis on fishing on floating objects. Also, data collected by the dolphin observer program highlighted the differences in the amounts of bycatch taken in the different modes of purse-seine fishing. The genesis of the working group lay primarily in the concern of coastal countries that the bycatch in the purse-seine fishery may have repercussions for the sustainability of stocks of fish exploited by other fisheries.

For the purposes of the working group, the operational description of bycatch is the part of the capture that is not used (Figure 1). It was noted that this definition also included discards of unwanted tunas. Utilizing all the species taken would change the issue from one of bycatch to one of catches of small fish, but it was noted that there might be practical problems in storing all the species on a purse-seine vessel, and the question of sustainability related to how much of an ecosystem could be safely removed would still remain.
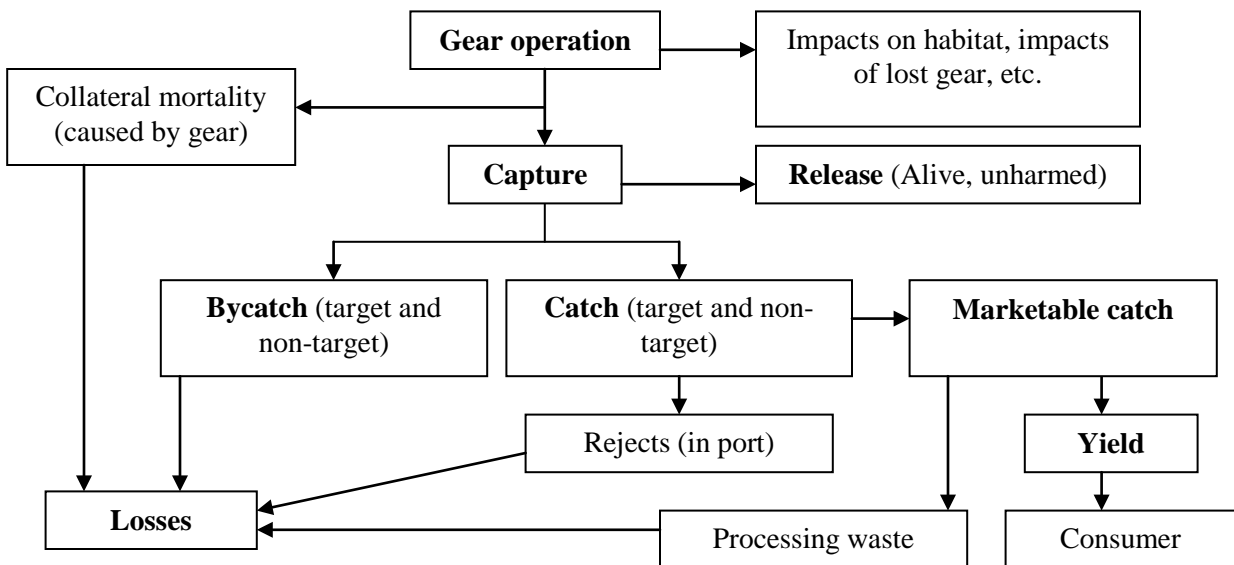

Figure 1. Ecological impacts of fishing operations

With current purse-seine technology there is little opportunity to release unwanted species alive before they are crushed when the catch is concentrated in the sack.. The exceptions are some large fish, turtles, and dolphins.

The IATTC staff described the data collected by observers on purse-seine bycatch, including discarded tunas, and the food habits database, which comprises data on stomach samples of predatory fish and dolphins. The meeting noted that, in general, observer data are available only for Class-6 purse-seine vessels. Dr Compean described a scheme used in Mexico for estimating the bycatches of smaller purse-seine vessels: for sets on floating objects or schoolfish, these estimates were much lower than the levels observed on larger vessels.

The group noted that, in order to assess the significance of bycatches from an ecological perspective, it would be necessary to take into account the catches and bycatches of longline vessels and smaller purse-seine vessels. It was noted that other data may exist, for other parts of the purse-seine fleet and/or for other fisheries, and that it would be important for the group to obtain such data.

3. *Incidence and distribution of bycatches in the purse-seine fishery*

The IATTC staff presented various analyses of the bycatch data illustrating the incidence and distribution of purse-seine bycatches in the EPO. These analyses showed differences in the spatial and temporal concentrations of the various species, and also showed that bycatches associated with floating objects tended, for all species, to be composed of smaller individuals.

In the central and western Pacific, a more limited observer program has provided bycatch data for a sample of purse-seine and longline trips. Bailey, Williams and Itano have reviewed these data[1] and, although the reliability of the overall estimates was low because of the small sample size, it is clear that bycatches were lower than those in the EPO. Rates of purse-seine bycatch (excluding tunas) and discards of tunas were both less than 1%[2]. In the Atlantic Ocean there is no systematic observer program, and only qualitative data are available. The taxonomic groups that appear in the bycatch in both the Atlantic and western Pacific Oceans are similar to those in the EPO.

4. *Ecological studies and modeling*

Dr. Martín Hall presented data showing that, in general, the bycatches in sets on floating objects contain a much greater diversity of species than other types of sets. They contain a variety of fauna, including elasmobranchs, billfishes, other large pelagic teleosts (wahoo, mahi mahi, yellowtail, rainbow runners), and several species of small pelagic fishes that are not always identified to the species level by the observers. Sea turtles are also frequently encircled in the nets, but in many cases they are released alive. Occasionally, large aggregations of jellyfishes are caught in the nets.

Maps showing the number of species encountered during 1993-1997 in the different types of sets and overall were presented. Examples are shown in Figures 2 and 3. For school sets, the areas with the greatest species diversity are on both sides of the Baja California peninsula, the Gulf of Tehuantepec, and in the Panama Bight. For dolphin sets, the greatest diversity is found off the coast of Central America, and for sets on floating objects, along a strip between the equator and 5°N. The location of these areas

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[1] By-catch and discards in Western Pacific tuna fisheries: A review of SPC data holdings and literature. Oceanic Fisheries Programme, Technical Report No. 34.
[2] Lawson, T.A. 1997. Estimation of bycatch and discards in central and western Pacific tuna fisheries: preliminary results. Internal Report No. 33 (revised July 1997). Oceanic Fisheries Programme, South Pacific Commission, Noumea, New Caledonia. 30 pp.

may be determined in part by geographical or oceanographic features that allow the coexistence, or seasonal replacement, of coastal and pelagic species, or northern and southern components of the ecosystem.

Figure 2. Distribution of purse-seine bycatches of mahi-mahi (*Coryphaena* spp.)

Figure 3. Length composition of mahi-mahi in purse-seine bycatches, by quarter

Dr. Michael Hinton discussed research on the ecology of billfishes and associated communities in the EPO. The objectives of this research are to develop information on the ecology of billfishes at a small spatial and temporal scale, to identify the structure of the communities and the aggregations of species with which billfishes may be associated, and to understand how billfish are related to other species and the physical environments of their pelagic communities.

The presence of blue and black marlin has been found to be positively correlated with indices of the total biomass of the aggregation of fishes associated with floating objects and with unassociated schools of tunas. Similar relationships were not found for striped marlin or for blue and black marlin with aggregations associated with marine mammals.

Analyses indicate that in two years, 1993 and 1997, there were significantly fewer number of species in aggregations associated with floating objects than during 1994-1996. It is not yet clear why this occurred, and hypotheses such as changes in environmental conditions are being investigated.

The presence of blue marlin and of oceanic whitetip sharks were both positively correlated with the number of species in aggregations. Similar results may be found for other billfishes and sharks. Preliminary results of recurrent group analysis conducted on data from sets on floating objects identified a recurrent group consisting of the following fishes: mahi mahi, skipjack tuna, wahoo, bigeye tuna, blacktip shark, yellowfin tuna, triggerfish and rainbow runner. Species which were found to be closely associated with one or more of the members of this recurring group included blue marlin, oceanic white-tip sharks, silky sharks, and yellowtail.

Examination of species-specific diurnal patterns of association with floating objects for about 25 species of fishes has identified species for which the probability of encounter (or presence) diminishes over the course of the day. Examinations of the patterns of association with unassociated schools of tunas are in progress.

Dr. Robert Olson presented an overview of information on food-web interactions and predator-prey dynamics in the EPO, and briefly described an ecosystem modeling approach for exploring the ecological implications of alternative fishing strategies in the EPO.

Predator-prey interactions are best known for the tunas. The food habits of yellowfin and skipjack tunas were studied during 1957-1959, when the baitboat fishery operated in coastal areas, and during 1970-1972, using stomachs from yellowfin tuna caught in association with dolphins by purse-seine vessels in offshore areas. Recently, however, stomach and tissue samples were collected from tunas and several associated predator species caught by the EPO purse-seine fishery (Table 1). The stomach contents have been identified, and a subset of the muscle and liver tissues were analyzed for stable C and N isotope ratios, indicators of trophic status. These samples provide the first data available for the EPO on a community and food-web scale. Analysis of the data is currently in progress.

A theoretical basis provides support for the hypothesis that fishing for predators at or near the top of pelagic, multi-level food webs imparts a "top-down" effect on the ecosystem via reciprocal changes in abundance at adjacent trophic levels. No direct evidence of ecosystem effects of fishing exists for the EPO. The IATTC has begun a modeling effort to identify potential ecosystem-level trends expected from alternative fishing strategies, *i.e.* sets on dolphins, floating objects, and schoolfish. Initial plans include incorporating a mass-balance model, originally known as Ecopath, interfaced with a new dynamic component, Ecosim, which simulates changes in fishery exploitation at the higher trophic levels. Figure 4 shows some of the predator and prey groups currently planned for inclusion in the EPO model, and shows preliminary feeding relationships based on the raw, pooled diet data.

Table 1. Numbers of predators from the EPO sampled for stomachs and tissues (muscle and liver) during 1992–1994.

Predator		Number
Spotted dolphin	*Stenella attenuata*	311
Spinner dolphin	*Stenella longirostris*	209
Common dolphin	*Delphinus delphis*	51
Striped dolphin	*Stenella coeruleoalba*	5
Yellowfin tuna	*Thunnus albacares*	4831
Skipjack tuna	*Katsuwonus pelamis*	1205
Bigeye tuna	*Thunnus obesus*	80
Black skipjack	*Euthynnus lineatus*	100
Frigate and bullet tuna	*Auxis* spp.	55
Blacktip shark	*Carcharhinus limbatus*	262
Silky shark	*Carcharhinus falciformis*	64
Oceanic whitetip shark	*Carcharhinus longimanus*	30
Bull shark	*Carcharhinus leucas*	2
Unidentified carcharhinid sharks	*Carcharhinus* spp.	82
Hammerhead sharks	*Sphyrna spp.*	48
Mako shark	*Isurus oxyrinchus*	4
Blue shark	*Prionace glauca*	2
Thresher sharks	*Alopias* spp.	12
Whitenose shark	*Nasolamia velox*	2
Black marlin	*Makaira indica*	25
Blue marlin	*Makaira mazara*	15
Unidentified marlin	*Makaira* spp.	18
Striped marlin	*Tetrapturus audax*	8
Sailfish	*Istiophorus platypterus*	49
Mahi mahi	*Coryphaena hippurus*	545
Wahoo	*Acanthocybium solandri*	235
Rainbow runner	*Elagatis bipinnulata*	48
Total		**8298**

The participants suggested that the associations shown by the data should be analyzed in terms of ocean provinces in the area. Different provinces probably contain different ecosystems, which would require different models. In this respect it was noted that the eastward-flowing Equatorial Current might maintain a separation between ecosystems north and south of about 5° N, at least in the western parts of the fishery, during most years. The extension of that current towards the east changes with the seasons, being close to the coast for much of the year, but far from it during winter and early spring, leaving a period when there is no clear boundary between the two regions. Such boundaries might apply to some species, but not others. In addition, the communities associated with floating objects are likely to be different to the aggregations of species taken in other set types.
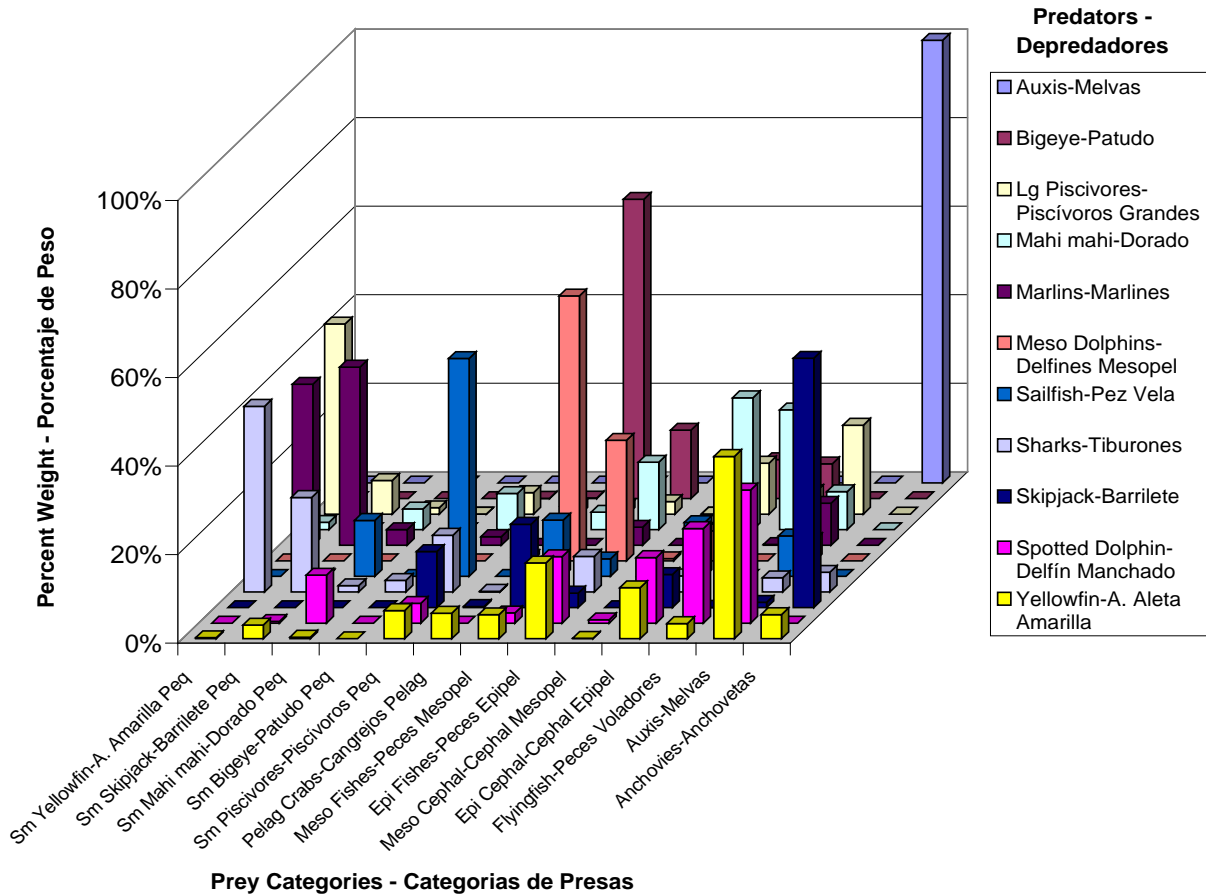
Figure 4. A subset of the predator and prey categories to be used in an Ecopath/Ecosim modeling effort for the eastern Pacific Ocean, and preliminary feeding relationships among the groups.

The participants agreed that Ecosim/Ecopath provides a useful starting point for modeling community dynamics, given the wide use of the approach and the fact that it requires that the analysis include all parts of the system. Some participants commented on the complexity of dealing with large pelagic species, living over vast ocean areas. The trophic level of these species changes as they grow; they also occupy different levels in ecosystems in which upwelling is the major source of productivity than in others where the role of upwelling is less significant. These complexities are in conflict with the simplifications required for the normal level of detail represented by the model.

The importance of climatic changes, such as the decadal scale changes which appear to be very influential in the North Pacific, was considered. In the EPO the major climatic variation is associated with El Niño events.

It is possible, however, that human activity will prove to be more significant than climatic or other natural factors. The purse-seine fleet which started fishing for tunas associated with dolphins in the early 1960s apparently reduced the size of the yellowfin population significantly. By the late 1970s the purse-seine fleet had expanded sufficiently to reduce the yellowfin stock to the lowest levels ever observed. Subsequently vessels left the fishery, and by the mid to late 1980s the stock increased to the highest levels observed.

5. *Technology and fishing techniques*

The IATTC staff described the typical configuration of purse-seine nets used in the EPO. They have been developed to be as effective as possible in releasing dolphins, and include a large dolphin safety panel of 1¼-inch mesh webbing, which effectively retains other bycatch. Some of the possibilities that have been considered for reducing bycatches after the fish have been encircled include hexagonal mesh in the safety panel, a rigid sorting grid which could be laced into the net at or before "sack-up," and holding the net open for a period to allow the catch to segregate itself by size or species, which might facilitate selective releases.

The staff is planning to carry out a preliminary trial of one of these possibilities at the Achotines Laboratory by observing the behavior of tunas when confronted with a sorting grid.

Several points were made in the subsequent discussion. The feasibility of a sorting grid in a tuna purse-seine has not been tested, and it is likely that the cost of development of a suitable grid would be high. The use of sound, light or bubbles to herd the fish might be investigated. Hexagonal mesh might allow the escape of small fish, but it would not be useful for unmarketable individuals of equal or greater size than the tunas which are to be retained, and it might increase the risk of fish being gilled. The approach of holding fish in the net to allow them to stratify, and then selecting the desired catch, should be investigated. Initial studies should focus on behavior of different species and sizes of fish in a net.

The importance of distinguishing between the release of unwanted fish and their later survival was stressed.

Another option was to avoid or minimize the capture of particular species. The data presented showed that some species appear to be more or less randomly taken throughout all or most of the area fished, while others are more aggregated in time and space. Some bycatch might be reduced by avoiding particular areas and seasons or changing fishing practices, for example by setting on floating objects in the evening rather than in the early morning. Another possibility was to design a net which fished below, say, the top 10 meters of the sea.

Tunas are being taken in the Bay of Biscay by mid-water trawling. While this might avoid bycatch of species associated with floating objects, tests in the western Atlantic showed relatively large catches of marine mammals.

6. *Management*

It is clear that none of the ideas discussed would be useful in avoiding or reducing bycatches of all species, and hence one part of any management approach would have to be defining the priority for reducing bycatches of particular species or groups of species.

7. *Future schedule and organization of work*

The working group agreed that two working subgroups, "Ecological Studies and Modeling" and "Technology and Fishing Techniques," should be established to carry out more detailed work. The Chairman would report on progress at the October meeting of the IATTC, and the subgroups should aim to work with a timetable which will allow a meeting of the main group prior to the June 1999 meeting of the IATTC, so that a more substantive report could be made then.

8. Other business

The working group wishes to bring to the attention of the IATTC two points that should be addressed to facilitate its work.

1. Small purse-seine or longline vessels take significant quantities of unmarketable fish of some species. In these cases the ecological significance of bycatches of large purse-seiners can be evaluated only if data on the other components of the fishery are also available. In light of this, the Commission may wish to widen the mandate of the group.

2. It is not likely that all facets of any bycatch problem can be solved simultaneously. The working group therefore seeks guidance from the Commission on priorities indicating which species or groups of species ought to be the main focus of its investigation.

Annex 1.

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Annex 2

AGENDA

1. Welcome, introductions, consideration of agenda

2. Introduction

   Description of the purse-seine fishery in the eastern Pacific, background to concerns about bycatch, and the Commission's 1997 resolution

3. Incidence and distribution of bycatch in the purse-seine fishery

   (a) Presentation based on the IATTC observer bycatch database providing the incidence and distribution in time and space of bycatches, association among species and with floating objects

   (b) Discussion

4. Ecological studies and modeling

   (a) Presentation based on IATTC research and proposals for future work

   (b) Discussion

5. Technology and fishing techniques

   (a) Presentation of ideas for IATTC research and summary of other gear developments which may have application

   (b) Discussion

6. Management

7. Future schedule and organization of work

8. Other business