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EXPLORATION OF MARKET VIABILITY FOR THE FULL RETENTION OF NON-TUNA SPECIES IN PURSE SEINE FISHERIES: INTERIM REPORT

Antony Lewis

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INITIAL SUMMARY

Purpose

This is the report of the first Phase of a study contracted by ISSF on tropical tuna purse seine fisheries to (1) review bycatch levels, (2) review available information on current retention policies by RFMOs (and companies, if applicable), (3) visit major landings sites/ports to profile landings, processing capability, market demand and existing artisanal fisheries, and (4) identify a minimum of two pilot projects to test market viability.

Bycatch definition

In this study, bycatch is defined as incidental catch, whether retained or discarded, and includes various finfish species plus sharks and rays. It does not include marine reptiles (turtles), marine mammals (dolphins, whales) or whale sharks. Retained bycatch may be referred to as by-product if marketed.

In most considerations in the study, small/damaged target tuna species are included, as they are often traded as the same commodity in the often informal market place, are subject to total retention measures in three tRFMOs and constitute the majority of by-product plus discards in most situations.

Trip coverage

A field trip (58 days travel with 113 interviews) provided good representative coverage of each ocean region: EPO -Ecuador (Manta, Posorja), Atlantic (Tema, Abidjan), Indian Ocean (Seychelles, Mauritius, Madagascar) and WCPO (Tarawa, Honiara, Majuro, Pohnpei), plus visits to the four tRFMOs; some obvious gaps in this coverage include Colombia, Central America, Senegal, Kenya and Rabaul (PNG) but the main locations where ISSF Participating Companies operate have largely been covered.

Literature review and information gathering on identified topics is ongoing. Shark and ray bycatch will require specific attention.

Summary observations

Bycatch and minor tuna species volumes in purse seine fisheries are relatively small (<5%), except in the Atlantic (*faux poissons*), but are nonetheless an important and highly visible source of waste, as well as presenting potential ecosystem issues.

Bycatch (including small tunas) in tropical pure seine tuna fisheries is largely, but not entirely, a FAD issue and would usefully be addressed concurrently with other issues relating to FADs.

Species composition of bycatch is qualitatively very similar amongst oceans areas/fisheries but bycatch rates vary amongst ocean areas. The WCPO appears to have the lowest bycatch rate and the Atlantic ocean the highest, with much of this regional variation seemingly due to variations in the catch of minor tunas.

High levels of observer coverage, which are the main source of information on bycatch and discards, are currently available in two tRFMOs only (IATTC, WCPFC).

Bycatch and discards in the WCPO fishery which provides more than half the global tuna purse seine catch, are possibly underestimated and need more careful study.
Supply chain and post-harvest utilization data which would allow evaluation of total bycatch retention are generally lacking.

Review of CMMs

Three tRFMOs have total tuna retention requirements; none have bycatch retention measures but several have non-binding resolutions; level of compliance with the existing measures is known with certainty in one RFMO only (IATTC).
A range of measures common to most tRFMOs addresses ETP concerns.

General conclusions

Current utilization of bycatch appears almost complete in two oceans (EPO, eastern Atlantic) but is probably less than 20% in the western Indian Ocean and less than 5% in WCPO, which may supply the largest quantum of bycatch due to the overall size of the fishery.

Marketing considerations

No one size fits all when considering solutions to landing and marketing bycatch and small tunas in the various unloading and transhipment points; economic viability of bycatch marketing at unloading/transhipment points is clearly related to population, local economy and hence local demand, the quality of fish unloaded, and distance from alternative markets. Two broad activity streams to deal with bycatch marketing can generally be observed (formal, informal), with the former more often resulting in good profitable outcomes, as well as generating more reliable information on bycatch in the process.

Pilot projects

Two oceans where most bycatch is already largely utilized (>90%) offer less obvious prospects for pilot projects, although there is a need for increased data gathering on at-sea activities and the subsequent supply chain in at least one case (e.g. Tema, Ghana). The focus needs rather to be on the western Indian Ocean and the WCPO where the majority of bycatch and small tuna can be expected to be caught, but currently with low levels of utilization. Several pilot projects in these two priority ocean areas are being pursued, but the WCPO in particular offers many challenges.

Next steps

- Develop and formalize pilot projects, clearing first with ISSF for suitability and any possible funding support needed. More focus needed on WCPO initially, and IO as secondary.
- Continue the review of all aspects of the bycatch/small tuna situation in all regions and to collect information as it becomes available in designated areas, noting that the situation is dynamic.
- Collect more information on at-sea practices – storage, handling,

retention/discards, onshore marketing mechanisms, and encourage RFMOs to begin to collect supply chain information on a routine basis.

- Final report to be submitted in mid 2015.

1. INTRODUCTION

1.1 Background

Full retention and subsequent utilization of non-target species is one way in which the wasteful practice of discarding fish at sea can be reduced. This report corresponds to the first phase of a 2-phase study contracted by ISSF to better understand the potential for bycatch utilization in tropical tuna purse seine fisheries.

The ISSF study has the ultimate objective to implement regional projects to understand market and other impacts of retained fish being landed, with special emphasis on avoiding conflicts with subsistence and artisanal fisheries and enhancing food security through the development of durable local markets for retained fish. For the period 2013-2015, the study aimed to identify two or three specific coastal countries for pilot projects, such as in the Western Pacific and Western or Eastern Africa, with the individual projects designed to explore the market viability of a retain-all strategy in different cases:

(i) Cases where the processing plants can utilize the bycatch (e.g. to make fishmeal or other products) without substantially impacting local fishers;

(ii) Cases where local markets can buy and re-sell the bycatch without significantly undermining subsistence fishers or coastal fishing communities;

(iii) Cases where reliable transportation options exist to market the bycatch outside of the port of landing, without undermining the viability of local businesses or fishers;

The study has been divided into two phases, below. This report corresponds to Phase 1. A subsequent report will be produced for Phase 2.

Phase 1 (2014)

- Review bycatch levels by ocean/fishery and by set type/species (finfish species and sharks, though little attention given to rays and sharks since not usually marketed).
- Review of all available information on current retention policies by RFMOs (and companies, if applicable); some will have non-retention/release policies, notably for shark species, and applicable conservation and management measures.
- Visit major landings sites/ports visits and profile landings/processing capability/market demand/existing artisanal fisheries and the supply chain at each site.
- Identify a minimum of two pilot site locations and design trials, with the cooperation of ISSF participating companies, associated purse seine fleets, local fisheries and

resource management authorities, to test market viability with respect to the three identified marketing cases (see above) and any other scenarios as identified.

Phase 2 (2015)

- Review pilot project outcomes after 6-9 month trials (early-mid 2015).
- Report to ISSF SAC, March 2015.
- Monitor and maintain dialogue during the trials (one visit to each pilot site).
- Monitor RFMO and national retention policies and developments during this time.
- Evaluate pilots and prepare recommendations for the consideration of the SAC (August, 2015).

1.2 Scope of the project (Phase 1) and methodology employed

The project, being global in scope, involves all significant ports where larger tuna purse seine vessels (say >250 GT) unload or tranship. Special consideration was given initially to sites where ISSF Participating Companies or vessels on their Proactive Vessel Register (PVR) operate. The locations visited during a 58-day trip, given these considerations, provided good representative coverage of each ocean region: EPO - Ecuador (Manta, Posorja), Atlantic (Ghana, Abidjan), Indian Ocean (Seychelles, Mauritius, Madagascar) and WCPO (Tarawa, Honiara, Majuro, Pohnpei), plus visits to the four tRFMOs. Some obvious gaps in this coverage include Colombia, Central America, Senegal, Kenya and Rabaul (PNG) but the main locations where ISSF Participating Companies operate have largely been covered. A total of 133 experts were interviewed in this phase of the study.

1.3 Definitions and coverage

For the purposes of this study, and given the emphasis on marketability, bycatch was defined as catches, whether discarded or not, of species other than the principal target tuna species (here defined for tropical tuna fisheries as skipjack, yellowfin and bigeye) and would generally include the following generic groups:

- Minor tunas (little tunas (*Euthynnus)*, frigate/bullet tunas (*Auxis),* bonitos (*Sarda*))
- A suite of other finfish species such as rainbow runner, dolphin fish (mahi mahi), wahoo, mackerel scad, barracuda, amberjacks, trigger fish, etc.
- Billfishes (marlins and sailfish)
- Sharks and rays, unless retention is prohibited by RFMO or national regulations

Marketed bycatch is known as by-product by various authors e.g. Amande et al. (2012). Bycatch may also be known as incidental catch or non-target species catch, but the latter term is subjective and has been avoided here. When the term "*target tunas*" is used in the study, it refers specifically to the three main tropical tuna species (skipjack, yellowfin and bigeye tunas) unless otherwise stated, and does not include the mostly neritic minor tunas (even though these are sometimes targeted in fishing operations).

Not included as bycatch in this study are ETP species: marine mammals (whales, pilot whales, dolphins), whale sharks, marine reptiles (sea turtles) and seabirds. The ETP species

have not been included in the considerations of this study, as noted, primarily because they are not marketable, and are also covered by management measures (CMMs – see Section 3) and research in other domains that aim to minimize or avoid their capture and ensure their release. **Table 1** provides a list of the more common bycatch species and their occurrence in the four ocean regions.

Table 1. Main bycatch species groups, with indications of relative abundance by ocean region (Qualitative ranking: ●● = abundant, ● = common, R = uncommon/rare)

Species		**WCPO**	**EPO**	**Atlantic**	**IO**
MINOR TUNAS, BONITOS					
Black skipjack, kawakawa	*Euthynnus* spp.[1]	●	●●	●●	●
Frigate tuna	*Auxis thazard*	●	●	●	●
Bullet tuna	*Auxis rochei*	R	●	●	●
Bonitos	*Sarda* spp[2]	R	●	●	●
BILLFISH					
Blue marlin	*Makaira nigricans*	●	●	●	●
Black marlin	*Istiompax indica*	●	●	●	●
Striped marlin[3]	*Kajikia audax*	●	●	●	●
Sailfish	*Istiophorus platypterus*	●	●	●●	●
SHARKS					
Silky shark	*Carcharhinus falciformis*	●●	●●	●●	●●
Oceanic white tip	*C. longimanus*	●	●	●	●
Hammerhead sharks	*Sphyrna* spp.	●	●	●	●
Manta , devil rays	*Mobula* spp., *Manta* spp.	●	●	●	●
FINFISH					
Rainbow runner	*Elagatis bipinnulata*	●●	●	●●	●●
Mahi mahi	*Coryphaena hippurus*	●●	●●	●	●●
Wahoo	*Acanthocybium solandri*	●	●●	●	●
Barracuda	*Sphyraena barracuda*	●	R	●	●
Mackerel scad	*Decapterus macarellus*	●	●	●	●
Trevallies, jacks	*Caranx* spp.	●	●	●	●
Yellowtail	*Seriola* spp.	●	●	●	●
Triggerfish (ocean)	*Canthidermis maculata*	●	●	●	●
Filefish	*Aluterus* spp.	●	●	●	●
Drummer	*Kyphosus* spp.	●	●	●	●

[1] *affinis* in WCPO and IO, *lineatus* in EPO, *alletteratus* in Atlantic
[2] *orientalis* in WCPO and IO, *chiliensis* in EPO, *Sarda sarda* and *Orcynopsis unicolor* in Atlantic
[3] White marlin (*Kajikia albida*) in Atlantic

The quantity of sharks landed appears to have declined in most cases, due to a combination of non-retention for certain species under CMMs, discards of live (and possibly dead) sharks, and a general decline in numbers (and size) of some species in purse seine catches as a result of over-exploitation (though not necessarily as a direct result of purse seine catches relative to the much larger longline catches). In many cases, retained sharks may not be marketable and may require separate storage onboard because of ammonia/urea content in the flesh.

It has been necessary in most instances to include consideration of the catch of small or damaged individuals of the three target tuna species, whose total retention is now required

by several RFMOs (Section 3), as they face the same marketing challenges, onboard storage issues and may compete with -- or supplement -- bycatch finfish species in unloading points. In many situations, these small or damaged tunas are regarded as the same commodity, for example the "*faux poissons*" that are landed and marketed in the Eastern Atlantic which include both minor tunas and small target tuna species.

The IATTC definitions (Hall and Roman, 2013) of by-catch (= discards dead), catch/capture (= all retained species) and releases (live and unharmed – including ETP species), while intuitively appealing and logical, have not been used here primarily because time-series information on discards other than of target tuna species is generally not available outside the Eastern Pacific Ocean and, more recently, the WCPO.

2. BYCATCH LEVELS BY OCEAN AREA/FISHERY, AND SET TYPE/SPECIES

Much of the information for this section has been drawn from the excellent extensive review by Hall and Roman (2013, which contains published data up to 2009/10), updated where appropriate with more recent published information (e.g. Restrepo, 2011) and with information gathered during the present study.

2.1 Data sources: Most data on bycatch retention and discards comes from observer programmes, with minor amounts from logbook coverage and, more recently, e-monitoring. Only two RFMOs have 100% coverage for larger industrial purse seiners: IATTC for 20 years, and WCPFC since 2010 (3 years of data, although not all currently processed and available). All other observer programmes require statistical procedures to estimate the required totals from samples that are in some cases very limited. It is usually recommended that 10-20% observer coverage is required to obtain acceptable estimates of bycatch (Amande et al., 2012) but such coverage levels do not always allow verification of compliance (e.g. with total tuna retention required by IOTC). Few data are available on utilization and post-landing or post-transhipment fate of bycatch and small/damaged tunas, and collecting supply chain information seems currently beyond the remit of tRFMOs.

2.2 General points concerning tuna bycatch/small target tuna catch from purse seiners

The following general points (first impressions) are made at this stage, and will not prejudice the findings of a more detailed review in the future.

2.2.1) The global volume of bycatch from tropical tuna purse seine fisheries is small relative to other fisheries

Bycatch as defined (non-target catch, retained and discarded) constitutes possibly around 2% of the total landed tuna catch[1], and possibly less than 60,000 t globally each year. When small/damaged target tunas are added to that, the total volume of "bycatch + small tuna" in tropical tuna fisheries, whether retained or discarded, may be less than 100,000 mt, from a purse seine tuna catch of around 2.9 million tonnes (see **Table 2,** below), or about 3%. This estimate of the bycatch plus small/damaged tuna which is potentially available for

[1] Restrepo (201) gives a weighted global bycatch rate of 1.62%.

trade/utilization should be regarded as very preliminary and mainly useful to provide a basis for identifying relative magnitudes and identify gaps in information.

The *faux poissons* of the Eastern Atlantic may be a special case where 30,000 t of "bycatch plus small tuna" is landed in one port alone (Abidjan) which finds ready markets and almost certainly needs to be regarded as by-product.

Table 2. Preliminary estimates of total purse seine bycatch (and small tunas) by ocean region. These estimates are drawn from available literature and are preliminary and subject to revision; they are intended to provide a basis for identifying relative magnitudes.

Area	Component	Estimated bycatch +	Purse seine catch (tunas)	Ref	Comment
Indian Ocean			**300,000t**		
	Bycatch (no t/tunas)	**8,284t**	(2.67%)	10	2003-07 obs data; EU fleets
	BC plus t/tuna spp. " " (Average)	**14,190t** **11,590t** **9,588t** **(11,800t)**		1 2 3 PET	4.73% of 300,000t 2003-09 obs data Observer data
WCPO			**1,800,000t**		
	Bycatch (no t/tunas)	**20,698t**	(1.18%)	10	2005-10 obs data (SPC)
	BC (discarded) WCPO BC only – PNA EEZs (7) Tuna discards (US fleet) Tuna discards (all fleet BC + tuna discards (est)	**13,118t** **3,661t** **1,115t** **~6,000t** **(~ 27,000t)**		4 5 4 6 PET	2010 estimate 2000-10 obs data 2010 US p/s fleet 2013 estimate Underestimated ?
EPO			**550,000t**		
	Bycatch (no t/tunas)	**7,258**	(1.35%)	10	2000-09 obs data (IATTC)
	BC capture + discard, tuna discards	**13,816t**	(2.5 %)	7 8	2009 ests 2013 est
Atlantic			**250,000t**		
	Bycatch (no t/tunas)	**7,764t**	(6.33%)	10	2003-07 obs data EU fleets
	BC + tunas (Abidjan) EAO total (Tema, Dakar)	**30,000t** **(36,000 t)**		9 PET	*Faux poissons*, 2009 *Faux poissons*, est 2009
	TOTAL BYCATCH[11]	**44,004**			
	TOTAL BC + DISCARDS, ALL P/S FLEETS	**~ 90,000t ?**	**2,900,000t**		

Refs.: [1] ACP Fish II report 2013, [2] Amande et al. (2012), [3] Ardill et al. 2013 [4] Chan et al. 2013, [5] Pilling et al., 2013, [6] WCPFC, 2013 [7] Hall and Roman, 2013 [8] IATTC data, 2014, [9] Chavance et al., 2011, [10]Restrepo, 2011, [11]EU fleets only for IO and AO; total for all fleets possibly closer to 50,000t; pet = preliminary estimates for total bycatch plus discards, all fleets, this study

This overall proportion of bycatch plus small tuna (provisionally ~3.0%) is much less than most other industrial fisheries, in some cases by an order of magnitude. Kelleher (2005) earlier estimated discards (late 1990s and early 2000s) from tuna purse seine fisheries at 5.1%. The level of discards is most likely lower than that now, with better estimation procedures and as a result of total tuna retention policies (e.g. total discards in the EPO represented 1% of the total tuna catch in 2012; 80% of these discards correspond to target tunas).

Given the sheer size of the tropical tuna purse seine fishery, however, bycatch volumes by ocean area may exceed the total fisheries production of many small island states. There is

thus a highly visible issue of waste prevention/reduction, but there are also situations where bycatch species may be overexploited (mostly in the case of some shark species) and where there are ecosystem harvest considerations. Whilst the issue of waste may be largely one of perception, it is nonetheless important to address and find solutions if possible. It may never be possible to achieve 100% utilization of bycatch species because of any of the following reasons:

- Fish species that are not marketable, edible or are too small;
- Fish that are unfit for consumption[2] due to spoilage or damage;
- Fish that are discarded on the last set of a trip due to limited well space;
- Fish that are discarded as a result of refrigeration issues, and
- Compulsory discarding (alive if possible) required

For these reasons, a utilization ratio of 80%, as currently achieved in the EPO seems an appropriate target or objective.

2.2.2) Mandatory retention of target tuna species is closely linked to bycatch retention and trade in most situations and they need to be considered together.

Small/damaged target tunas and bycatch species rely on similar markets and indeed may not even be separated as a commodity (e.g., *faux poissons* in Abidjan include both). Also, small/damaged target tunas may be larger in volume, especially since retention policies have been introduced by several tRFMOs. They can often be diverted to uses different than high quality bycatch are (e.g., fish meal and pet food production, both of which take place in processing plants). Tunas generally fall in the general lower-price end of the market, whereas high quality bycatch species such as mahi-mahi and wahoo can fall into higher value markets, albeit usually requiring better onboard handling and storage. The small/damaged tunas have generally preceded bycatch in penetrating local wetfish markets because of total retention policies for target tunas and represent competition at the lower end of most markets. On the other hand, bycatch species may be processed for export markets in some situations e.g. Ecuador.

In practical terms, bycatch (and small tunas) may normally not be sorted until transhipment or unloading unless high grading or well sorting is occurring for some species or sizes at sea.

2.2.3) The purse seine bycatch issue is largely a FAD issue

Put simply, most bycatch (and small tuna catch) in tropical tuna purse seine fisheries is taken from sets on floating objects (primarily FADs), which make up 40% or more of sets in most ocean areas. Pilling et al (2013) note that, in the WCPO, bycatch (selected finfish) from FAD sets is 15 times that of free/unassociated schools. However, it should be noted that the

[2] Not all tRFMOs define the term "unfit for human consumption" equally. WCPFC (CMM 2009-02) explicitly excludes from this classification catch that (i) is considered undesirable in terms of size, marketability, or species composition; or (ii) is spoiled or contaminated as the result of an act or omission of the crew of the fishing vessel. Some of the other RFMOs are not as explicit in their definitions and therefore there is more room for subjectivity in determining which fish can be legally discarded.

catch rates of target tunas on FAD sets were twice those of free schools and thus the bycatch rate (measured in t of bycatch per 1,000 t of tuna) would lower. Similar results about FAD sets contributing 80-90% of bycatch have been reported from other oceans (e.g. Amande et al., 2012, for the Indian Ocean). Dagorn and Restrepo (2011) however note that as a percentage of landings of target tunas, bycatch was lowest in the WCPO, highest in the AO, and that the ratio of FAD bycatch to free school bycatch varied from 2.8 (EPO) to 6.6 (WCPO). For some bycatch species groups such as pelagic rays and sailfish, the catch rate in free schools is higher than in FAD sets (IATTC data; Restrepo et al. 2014).

In balance, tropical tuna purse seine bycatch in many situations is a subset of the suite of FAD issues which are being addressed in an increasingly cohesive way at present and include eco-friendly FADs (non-entangling and/or bio-degradable), seeking ways to reduce the catch of undesirably small bigeye and yellowfin, reducing shark bycatch, improving data collected from FAD fishing, FAD management plans, limiting FAD numbers etc.

2.2.4) Bycatch species composition is similar amongst ocean areas but does show some variation

Table 1 summarizes the species or species groups occurring as bycatch in the four ocean areas, with some coarse indication of their relative abundance. There are insufficient data to compare, for example, relative bycatch biomass levels amongst these areas, with data gaps, differences in definitions etc. Restrepo (2011) notes that much of the regional variability in non-target species catch rate (bycatch), is due to the catch of "minor tunas" i.e. little tuna (*Euthynnus spp.*), bullet/frigate tunas (*Auxis spp.*) and bonitos (*Sarda spp.)*, etc). This accounts for much of the regional variation in bycatch rates, with WCPO the lowest and AO by far the highest.

It is possible, however, to generalize concerning the relative abundance of the main finfish bycatch species groups, excluding minor tunas as follows, from Hall and Roman (2013):

EPO: mahi-mahi > wahoo > yellowtail > rainbow runner
WCPO: rainbow runner > mahi-mahi > wahoo > barracudas
IO: rainbow runner > mahi-mahi > wahoo
AO: rainbow runner > wahoo > mahi-mahi

The pattern of dominance is most similar between the WCPO and the Indian Ocean, where the same suite of finfish bycatch species is shared. The EPO shows a reversal of the pattern seen in other areas, with mahi-mahi dominant and rainbow runner, the dominant species in all other areas, the least important of the main bycatch species. Along with changes in consumer preference by species, this may have implications for bycatch marketing strategies.

3. REVIEW OF CMMs, Resolutions

CMMS and Resolutions relating to total retention and tunas and bycatch, and measures for associated species (e.g. sharks, cetaceans, marine turtles, seabirds, whale sharks etc.) will be

comprehensively reviewed[3] and summarized but **Table 3** provides a general initial summary. Most, if not all, tRFMOs have a suite of similar measures relating to associated species (sea turtles, seabirds, cetaceans, sharks etc).

Table 3. t-RFMO bycatch and associated species management measures.

	Retention (target tunas, other species)	**Comment**	**Relevant CMMs for other species**
IATTC	Total retention of all target tuna catch since 2000 C-04-05 Consolidated resolution on bycatch	100% observer coverage since 1993; Retained and discards recorded by species (tuna, bycatch)	Sea turtles C-04-07/07-03 Sharks C-05-03 Oceanic white tip C-11-10 Seabirds C-11-02 FADs C-13-04
ICCAT	No target tuna full retention (since nearly all landed anyway) Information collection and harmonization of data on bycatch and discards 2011-10	100% observer coverage in Jan-Feb closure period Much lower outside this period	Sharks 2012-05 (2004), 07-06 Seabirds 2011-09 (2007-07) Silky shark 2011-08 Sea turtles 2010-09, 13-11 Hammerheads 2010-08 Oceanic white tip 2010-07 Shortfin mako 2010-06 Thresher sharks 2009-07 Closed area/season for use of FADs 11-01 and 13-01
IOTC	Total tuna retention (Resolution 13/11, previously 10/13) in force January 2014 Non-target species retention recommended – measure introduced May 2014 Annual Meeting , not adopted.	Low observer coverage; compliance unknown but probably low; few data	Sharks Resol. 13/06 (05/05) Seabirds 12/06 Cetaceans 13/04 Whale sharks 13/05 Thresher sharks 12/09 (l/l) Marine turtles 12/04 09/06, Procedure on a FAD Man Plan 13/08, succeeds 12/08.
WCPFC	Total target tuna retention since CMM 2008-01, into force 2010 (now 2013-01) Non-target fish species covered by Resolution 2005-03 (voluntary only)	100% observer coverage, monitored and discards reported. Bycatch capture recorded, but not fate (discard/retention)	Seabirds 2012-07 (2007-04) Sea turtles 2008-03 Sharks 2010-07 Cetaceans 2011-03 Whale sharks 2012-04 Oceanic white tip 2011-04 Silky sharks 2013-08 FAD Management 2008-01 (replaced by 2012-01 and 2013-01) – high seas only

Regarding *retention measures,* three of the four tRFMOs have adopted target tuna total catch retention policies – IATTC (2000), WCPFC (2008) and IOTC (2010, entry into force 2014) and several have considered extending this to non-target/incidental catch species (bycatch in the current context).

[3] A database of active CMMs and other resolutions adopted by RFMOs can be accessed at: http://iss-foundation.org/rfmo-resolution-database.

- An early draft of the WCPFC tropical tuna CMM contained such a proposal, which did not go forward, and WCPFC Resolution 2005-03 (non-binding) seeks the release and non-capture of non-target species.
- The current IOTC Resolution encourages "all purse seine vessels to retain on board and then land all non-targeted species as far as the vessel can ensure appropriate fishing operation (including but not limited to other tunas, rainbow runner, dolphinfish/mahi-mahi, triggerfish, billfish, wahoo, and barracuda) except fish considered unfit for human consumption". A proposal for by bycatch retention was tabled at this year's IOTC annual meeting (May 2014) but in the event was not adopted.
- The IATTC consolidated Resolution on bycatch - C-04-05 (REV 2) is still active but probably needs revision, as most species are now largely retained, not released.

Only ICCAT has no measure concerning total retention of target tunas, but is committed to collecting information on bycatch and discards and has recently appointed a specialist bycatch staff following a study to coordinate bycatch efforts (ICCAT, 2010).

Additionally, NGOs have also called for the retention of bycatch unless able to be released alive in some cases (e.g. WWF) and evaluation of the potential for full retention is the object of this study funded by ISSF.

4. FIELD TRIP PRELIMINARY FINDINGS

To facilitate this interim report, brief impressions are provided on the field visits to each of the four ocean areas. Additional information, notably profiles of the characteristics, production details, bycatch disposal and associated issues, will be provided for each port visited. A list of key persons contacted during the study is provided in the Acknowledgments.

4.1 Eastern Pacific Ocean (Ecuador)

Ecuador's tuna catch in 2013 was 230,700 mt, representing 42% of the EPO total catch of 550,000 mt, and more than 60% of the EPO skipjack and bigeye catch[4]. As a result of most of the Ecuador catch being dFAD-associated, Ecuador (Manta and Posorja) is thus the country where most bycatch would be unloaded. The 20 years of IATTC observer data provide a very good understanding of the current pattern of retained and discards in the EPO, as well as relative species abundance (see **Annex 2**):

- The amount of discards of tuna species (and, conversely, the amount retained) has declined to quite low levels over the past two decades: 1%-2% for FAD sets, and much less for free school and dolphin sets (<0.2%).
- Overall retention of edible bycatch species (billfish, mahi-mahi, wahoo etc.) has increased to over 75%, with most discards being small fish less acceptable in the market place. Discarding also continues for species with limited market

[4] IATTC set types as % of total: Dolphin 33%, school sets 25%, associated sets (mostly dFADs) 42%.

acceptability, notably yellowtail (*Seriola* spp.) and rainbow runner (*Elagatis bipinnulata*).

- Use of escape panels or sorting grids ("rejilla") is now widespread, with many small fish e.g. trigger fish escaping and not retained. One fleet is known to have reduced bycatch overall, but details not known regarding a different possible subsurface type of escape panel.

Observations during the visit include the following:

- Bycatch species provide economic opportunities: Previously seen as a bonus for crew, bycatch is now vessel business; onboard handling and storage have been modified to land a better product for processing and sale, and revenue is shared amongst crew.
- Small target tunas are relatively uncommon in the catch of EPO larger vessels – generally not an issue in EPO, and small tunas are processed anyway.
- With the large number of tuna canneries and fresh fish processing plants in Ecuador and the large population, opportunities exist for both processing small target tunas (canning, fish meal) and processing bycatch species, for domestic consumption (including feeding cannery workers) and export. Demand is strong.
- The purse seine production of mahi-mahi, the main bycatch species in the EPO, is dwarfed by the artisanal longline ("nodriza") production, much of which is exported to the US (Aires da Silva, 2013); there is little or no conflict with artisanal fisheries.
- Bycatch is commonly used by canneries of vertically-integrated companies to supply cannery canteens and feed the large number of workers; it also may be processed for local sale or sold whole to buyers for nearby processing plants.

Interim conclusion (EPO):

Most bycatch (80%) is being landed, marketed and fully commercialized. Some opportunity exists to develop markets for *Seriola* and rainbow runner ("salmonete") but the quantity is quite small.

It is noted that 12 large purse seine vessels now fish predominantly in the WCPO and overlap WCPO/IATTC area and tranship in port, mostly in Tarawa and Kiritimati. This study has not established the fate of that bycatch. It is presumably discarded at sea (which is not illegal), as the vessels are away for too long (up to 12 months) to retain quality product onboard, especially in brine, and there is very limited demand at the transhipment ports.

4.2 Eastern Atlantic Ocean (Ghana, Ivory Coast)

The Atlantic purse seine tuna catch was 250,000 t in 2012. The estimated Ghanaian catch for this year is 75,300 t from 17 purse seine vessels and the pole-and-line fleet. Some of it is unloaded for canning in Tema (2-3 canneries). In Ivory Coast just one vessel operates but much unloading (130,000 mt) by many fleets takes place, with the EU-flagged vessels being dominant. With relatively low observer coverage, most information comes from sampling unloading and removal by transports in port (Abidjan) though much less is known about unloading in Tema and Dakar.

Observations made:

- Of the ~130,000 t of total catch landed in Abidjan, 50,000 t are processed/canned locally (3 canneries), 55,000 t are transhipped and exported, and 25,000 t are consumed domestically[5]. Most of the latter is landed as *faux poissons*, a mix of small target tuna species: Skipjack and yellowfin/bigeye (> 50%), minor tunas (18%), mixed tunas and others. Data in the form of truck unloading by weight carried, in the port, and some length and species composition sampling are available. There is a low level of observer data collection but there are plans to increase it.
- Ghana: There is observer coverage since 2012 on all 7 vessels of one fleet most of the time; the quality of the data collected was not examined in this study. No information on marketing of bycatch ashore was available but there is large cold storage capacity. Demand is believed to be strong.
- Senegal (not visited): Pole-and-line and some purse seine fish are landed. There is one cannery. The bycatch situation is unknown.

Interim conclusion (AO):

Nearly all bycatch (>90%?) in the eastern Atlantic is assumed to be landed, along with small/damaged target tunas. However, few data are collected at sea to verify this. Discard rates are not known with any certainty; on-board practices have not been described.

4.3 Western Indian Ocean (Seychelles, Mauritius, Madagascar)

Indian Ocean total tuna catch in 2011 was 810,000 t of which ~ 300,000 t were caught by industrial purse seine.

Most (85%-90%) purse seine catch is unloaded in Victoria (Seychelles), some transhipped/unloaded in Mombasa, Diego Suarez and Mauritius. EU-flagged vessels deal with bycatch differently. Bycatch is mostly retained and marketed by Spanish vessels. One French fleet is, however, processing tunas and bycatch ashore in Port Louis, and may begin to sort in Victoria in the future.

- Victoria: Limited market, despite high per-capita consumption. It is estimated that roughly 2,000 t of bycatch are landed annually ~ 0.7% of tuna purse seine catch; assume some discards at sea or during transhipment. Some small tunas may go to fish-meal, pet food, bait etc, but little to direct human consumption. A large cannery takes 90,000 t per year and the remainder is transhipped in port. A new port development may allow sorting and export of bycatch for processing in Mauritius.
- Mauritius: Direct purse seine landings are limited, mostly to vessels from one company. Landings from carrier vessels, many from Victoria, supply two large canneries. There is high local demand (population close to one million people) but it is mostly met by longline bycatch and imports (~20,000 mt). Mauritius is developing as a major seafood-processing hub.

[5] More than 30,000 t in recent years

- Diego Suarez: It is a seasonal transhipment and slipping port for the EU-flagged fleet, but its use is in decline (now ~15,000 t or less). There is a strong local market for bycatch (~750 t marketed) and the end price is very high. There is informal marketing by stevedores etc.
- Mombasa (not visited): There has been reduced seasonal activity for some years due to piracy. Most bycatch is believed retained by a local processor (loins and local value-added) for a strong local market (175 t of bycatch in 2010).

Interim conclusion (IO):

Although some bycatch is marketed/utilized in the western Indian Ocean, it probably represents less than 20% of the available bycatch and there is potential to increase utilization as well as regional/inter-ocean trade in bycatch, both processed and unprocessed. Ample scope exists for pilot projects, which may be undertaken by companies anyway as a commercial enterprise. Observer coverage of the purse seine fleets is still limited and data on bycatch and discards are incomplete.

4.4 Western and Central Pacific Ocean (Majuro, Pohnpei, Tarawa, Honiara)

Tuna catch in 2012 was 2,573,000 mt, or 58% of the global catch. The purse seine catch consists of about equal amounts from free school and associated sets. Good data on bycatch exists since 2010 (from 100% observer coverage of industrial fleets) and also good data on discards of target tunas. However, less information is available on bycatch retention and subsequent marketing/trading. Most bycatch is sorted during transhipment; there are very limited local markets in 4 of the 5 main transhipment ports and it is assumed that most bycatch is discarded in port or at sea.

- Majuro: Now possibly the largest transhipment port in the WCPO (~400,000 mt), with limited local processing (4,000 mt) and low demand/small local market for bycatch (population size ~25,000 persons). Some minor volume of trading and export exists. It is assumed that most bycatch is discarded, possibly 2,000-4,000 mt.
- Pohnpei: Up to 200,000 t transhipped per year, decreasing in recent years. There is no local processing of purse seine caught fish, and longline bycatch is not allowed to be sold locally. There is a small amount of leakage/local trading for bait, pet food, and some human consumption (Pohnpei State population size ~35,000). Some discarding occurs on the way out of port, leading to several prosecutions.
- Tarawa: 120,000 t transhipped, increasing in recent years and includes 12 EPO vessels. Some bycatch (~200 mt) is unloaded voluntarily and marketed by a government agency, which has exclusive access as a low price food item. Longline catch is processed at a plant, and some is sold on local market via the government agency (South Tarawa population ~50,000). A large artisanal fishery is concerned about bycatch sales, but consumer demand is very strong from lower income earners and prevails over these concerns.
- Honiara: ~100,000 t transhipped, as well as ~30,000 t unloaded to the processing plant in Noro. Much leakage of small tunas and bycatch occurs in Honiara; possibly 500 t are traded in Honiara central, including fish brought from Noro by traders. Not all fleets trade, and therefore considerable amounts must be discarded. Demand is

strong (Honiara population ~65,000) but supply is not constant year round (notably with a gap during the 4-month FAD closure).

- Rabaul (not visited): Transhipment ~160,000 t, and stable. There is no local processing but there is much leakage/barter to meet strong demand for fish by the sizeable local population (East New Britain population ~300,000). Fish, often in hot-smoked form are distributed well beyond Rabaul/Kokopo.

Interim conclusion (WCPO):

WCPO supports the largest amount of tuna purse seine bycatch, yet currently, there is minimal utilization (< 5% of bycatch). Most fish (target tunas) are transhipped beyond the central part of the region for processing on the periphery or beyond (e.g., Thailand, Philippines and Ecuador). Demand in volume is low because of the generally low population in the main transhipment ports. Also ports are generally too far from possible markets to enable viable transport for processing and sale. Some potential exists for pilot projects to address this, which may be the most significant global bycatch utilization issue in tropical tuna purse seine fisheries.

4.5 General comments

Retention and discarding procedures

In several ocean areas, there are many gaps in the current understanding of when and where catch is sorted, where fish are identified for discarding or retention (e.g. on-deck, below deck in larger vessels, or sorted during transhipment or unloading). This affects the accuracy/precision of bycatch and discard estimates and our understanding of the potential for utilization. Associated with this are the onboard storage issues — whether or not separation of bycatch occurs following sorting, whether separate wells are used, and if high grading occurs. These are key issues for this study.

Finally, there are universal supply chain issues. In general, there is no interest in, or data available for, the fate of product once fish leaves the vessel. This is currently beyond the remit of tRFMOs in most cases, but emerging issues such as traceability, chain of custody for sustainability certification, and catch documentation schemes will require the engagement of tRFMOs.

In addition, there is a growing need to assess the effectiveness of total retention measures, in order to know if retained small tunas are utilized or discarded, and to ascertain if the measures are working as a disincentive to catch small tunas. It is also important to assess if market opportunities have been identified.

Marketing/demand related to population size at unloading points

A general observation made during the field trip is that demand for bycatch (and lower priced fish) is directly related to population (and income) at or near the landing or

transhipment points. This is almost certainly a more important factor than the presence of fish processing facilities in the location. This is particularly the case where the population is very large and food security concerns exist: Lower quality seafood is accepted especially if the price is low.

Fish may be semi-preserved (e.g. salted or dried) for a longer shelf life to enable transportation to markets further afield (e.g, to countries inland from Cote d'Ivoire such as Burkina Faso or Mali; to northern Madagascar from Diego Suarez; to the wider Gazelle Peninsula from Rabaul).

In other areas where population density is moderate to high, but income is higher, higher priced markets for preferred bycatch species (e.g. mahi-mahi or wahoo) have been developed (e.g., in Ecuador) or export markets where processing facilities and good product are available (e.g., Ecuadorean exports to USA).

Bycatch marketing considerations

The scope for this study identified three scenarios to be investigated:

(i) Cases where the processing plants can utilize the bycatch (e.g. to make fishmeal or other products) without substantially impacting local fishers;

(ii) Cases where local markets can buy and re-sell the bycatch without significantly undermining subsistence fishers or coastal fishing communities;

(iii) Cases where reliable transportation options exist to market the bycatch outside of the port of landing, without undermining the viability of local businesses or fishers;

Observations collected in this study so far indicate that it is difficult to assign situations to just one of these three scenarios. Many straddle several options and instead, two main marketing streams for bycatch (including small/damaged tuna) generally prevail at present. These two main streams are summarized below, and might be titled "informal" and "formal" (see **Table 4**). This might have partly followed the procedures and practices onboard French and Spanish purse seiners, respectively, in the Atlantic and Indian Oceans at one time, but they are becoming more similar in recent times with growing realization of the value of bycatch.

The latter approach (formal) has the advantage of increasing value and providing better data on bycatch sales and volumes. Any requirement for mandatory retention of bycatch would probably see the adoption of the formal approach by vessel owners/captains if economically feasible. The use of formalized marketing channels should also reduce competition with artisanal fishers if the product is going to higher-end or even export markets.

Table 4. Bycatch procedures and arrangements.

	Informal /unregulated	Formal /regulated
Bycatch ownership	Crew given tacit ownership of bycatch and small/damaged tunas; may process (salt/dry) onboard in some cases	Captain/fishing master retains control over bycatch storage onboard and disposal/sale in port
Sorting	Minimal sorting until transhipment or unloading, when most sorting occurs; some preferred species set aside for salting/drying in some cases	May be high grading and sorting below deck; live releases (sharks etc) on deck
Storage	Typically mixed in brine wells with target tunas; in some cases may be stored in wells above brine pound boards after initial chilling in brine for better quality;	Stored in separate wells or even dry wells for larger high value bycatch species e.g. mahi-mahi, wahoo. Crew consumption (small amounts) may be stored in food freezers for onboard consumption or take home
Unloading/ transhipment	Bycatch/small tunas put to one side and often not sold/transferred to trader until late in day, after hours in the sun	Bycatch unloaded when buyers/receivers available; longer time needed to unload dry freezers/wells
Cost to buyers/traders	Usually provided free (by vessel) with only scavenging/retrieval costs involved for buyers; crew retain sales or traded goods as traditional "bonus" entitlement	Usually sold at agreed price, possibly on pre-arranged sales contract; proceeds distributed amongst officers and crew, according to captain's judgment
Quality	Often poor with high salt content, but depends on time in brine, temperature etc; usually receives low price unless demand very strong e.g. Diego Suarez	Generally good; moderate-high price if dry freezer; may be brined initially to reduce temperature; high quality at -35^0C
Utilization	Where alternatives e.g. processing plants, may be used for fish meal, animal food, bait, and not often for human consumption unless very strong demand, fish supply is short or the low price is attractive for low income earners	Sold as whole fish or may be processed onshore for export and/or local consumption. A viable stand-alone business in some ports

Another consideration relevant to bycatch marketing, especially in the WCPO, is the distance and resulting transportation costs from alternative markets. The two biggest transhipment ports in the WCPO (Majuro and Pohnpei) lie thousands of miles from the nearest large markets such as South East Asia or South America, with high freight costs for whole round fish or processed products.

5. PILOT SITE LOCATIONS

The process of selecting a minimum of two pilot sites in this study has been guided by the following considerations:

1) Design trials with the cooperation of ISSF Participating Companies, associated purse seine fleets, local fisheries and resource management authorities.

2) Test market viability with respect to the three identified marketing cases (see **Table 4** above) and any other scenarios as identified.

It is clear from the field trip and other information available that the priority locations for pilot projects would most likely be in the Indian Ocean and WCPO where the lowest bycatch utilization exists, yet where the biggest challenges lie. It is therefore no surprise that few processing and trading companies have seen, let alone seized, any economic opportunities in bycatch marketing in these regions.

In addition to marketing trials, other possible situations might be considered for pilots, including the following:

- Collecting information, to help understand existing processes (e.g. Eastern Atlantic):
  Abidjan - information from vehicle carriers and their tonnage at port exists, but very little at-sea information is available, and the volume of at-sea discards is not well known.
  Ghana – some onshore marketing exists but no information is available on at-sea practices, including amounts discarded or retained, and details of trade onshore (species, volume).
- Fine tune/upgrade existing marketing initiatives, through increasing volume of fish traded, upgrading supporting facilities, developing new or more stable markets (e.g. Noro, Solomon Islands).

Some other concerns also need to be taken into consideration:

- Striving to formalize existing informal arrangements involving small-scale enterprises and players (e.g. leakage) in order to get improved information will possibly add costs to consumers and may affect demand.
- Formalizing arrangements may shift revenue from crew/stevedores (traditional bonus) more towards vessel owners/captains, although revenue sharing arrangements could be negotiated.
- Subsidies for trials may be needed in the first instance, in anticipation of total retention of bycatch in the future, and to provide some insights into marketing issues and problems.
- Can potential entrepreneurs learn from total tuna retention and marketing of those fish, and will these policies, if enforced, open up new opportunities?

As has been seen in this report, very few post-harvest utilization data have been collected or are available to inform potential entrepreneurs at unloading/transhipment points.

Table 5 below lists five possible pilot projects under consideration. The majority are at an early stage of development and have yet to be formalized. In terms of priorities for pilot projects, it is clear that the IO and particularly the WCPO provide the most under-utilized bycatch situations, with the great majority of bycatch discarded at sea and only minor amounts traded, either formally or informally.

It would therefore seem appropriate to proceed as follows:

- Develop and implement well-designed bycatch pilot projects in the WCPO as the initial priority, involving ISSF Participating Companies and/or vessels on the PVR wherever possible.
- Gather information on possible initiatives in the Indian Ocean, especially as the total retention policy (target tuna species and possibly bycatch in the future) is implemented. Involve ISSF Participating Companies and collaborating fleets.
- Consider other possibilities (e.g., Tema, Ghana) where possible.

Table 5. Summary outline of possible pilot projects

Location	Activity	Structure	Processing	Existing market	Market development	Local impact on fishers/vendors
SOLOMON ISLANDS Noro	Marketing quality bycatch species in Honiara	Crew of 5 purse seiners form credit union to market bycatch (onboard responsibility for quality)	Initially no – just whole fish; may process for value-added to higher end markets subject to good initial outcomes	Yes, Honiara – traders purchase in Noro so no transport needed; Year-round supply cf seasonal from transhipment leakage; likely initial volume < 100t	Needed if move to value-adding and higher priced local markets	No direct impact Noro; strong local demand for small tunas/bycatch in Honiara; initial market target < 25% of current leakage during Honiara transhipmet
KIRIBATI Tarawa	Expanding current marketing of bycatch	A government agency has exclusive access to bycatch. One large processing plant now underutilized	Plant is already processing some target species and bycatch for local markets and export	Well-developed artisanal tuna fishery can't meet strong demand; export markets price sensitive, cost is high	Not necessary for local; need to develop higher quality value-added by-catch product for export	Probably only moderate; low end of market. No impact of exports, but may create more employment in plant
PAPUA NEW GUINEA Rabaul (n/a)	Providing formal market outlet for leakage, gather information	Consultation needed to develop project (to replace/supplement informal leakage)	Whole fish only; buyers may smoke/salt fish for distant markets	Yes – unsure of size but large local population (300,000+)	Good market exists but informal prospects for expansion not well documented	Unlikely; strong demand and local supply of tunas etc limited
MAURITIUS-SEYCHELLES Port Louis, Victoria	Sorting bycatch, small tunas in Victoria; ship to Port Louis for processing; Process bycatch at sea; potential use for fishmeal	Will depend on construction of new port and cold storage in Victoria then processing in Port Louis	Sorting in Victoria, transport to and sell whole or processed fish in Mauritius; possible use as fishmeal	No additional market available in Victoria; yes in Mauritius, as imports ~20,000t of fish	Probably not necessary – study of project economics	Very little – current supply does not meet demand; no local fishery of any size
GHANA Tema	Observer coverage, info on retention and marketing of small tunas, bycatch (total retention trial)	Observers trained, working with FAO GEF-ABNJ project	Not necessary – buyers take whole fish from cold storage at port; fish from other fleets and in future maybe from IO	Strong demand in Accra and beyond; huge fish imports (180,000 t); bycatch and tunas 500-800t from purse seine vessels	Not needed unless move to value–adding but no real incentive to do so at this stage	Minimal – huge shortfall in fish supply /food security

6. Preliminary Conclusions

- Bycatch is defined in this study as marketable non-target species (by-product and discards), but it is recognized that, in many cases, catches/landings of small damaged tunas need to be considered as well. This is particularly relevant in situations where mandatory total retention of target species applies, as they are part of the market and may often compete with bycatch.
- Levels of bycatch, even when combined with small/damaged tunas, are low by the standards of other fisheries, and mostly <5% with the exception of the eastern Atlantic where the special situation of *faux poissons* occurs.[6]
- Bycatch/small tunas is largely --but not entirely-- a FAD issue in tropical purse seine tuna fisheries, and needs to be considered alongside the suite of FAD-related issues.
- There are considerable differences amongst ocean areas/fisheries in marketing bycatch, with a high level of bycatch utilization in the EO and Eastern Atlantic. No single approach addresses the marketing potential in each ocean area (i.e., "no one size fits all"): Different factors influence marketing viability in each ocean area, with the demand generated by large population in unloading/transhipment the main factor to consider in the first instance.
- The main challenge to dealing with bycatch issues, specifically reducing wastage and achieving at least 80% utilization, lies in two ocean areas: the western Indian Ocean and the WCPO, where bycatch utilization may be less than 20% and 5% respectively.
- In all ocean areas, there are significant data gaps. Complete observer data (100% coverage) are available for just two oceans and even those are not fully available in one case (WCPO – because of a data-entry backlog). Many aspects of at-sea procedures, from discarding to retention, sorting and storage are therefore not well documented globally. Despite promising trials with e-monitoring, it is unlikely that it will be able to completely replace observer coverage, at least in the near term, and especially with issues such as species identification (small tunas, bycatch).
- There is a need to begin to collect supply-chain information if bycatch marketing issues are to be scoped and understood. This seems an inevitable step for tRFMOs in the light of other parallel developments in catch monitoring and traceability.
- WCPO remains the ultimate challenge for bycatch utilization, with largest amount of bycatch (and even that is probably under-estimated). This is the case despite the low bycatch rate relative to other ocean areas, and comes about simply because of the volume of the tuna catch (> 50% of the global catch). WCPO bycatch is discarded for the most part at present and there appears to be no ready and obvious solution. The situation is subject to the tyranny of transhipment points widely dispersed over a vast fishing area, and in ports with low populations, and far from alternative markets.

[6] Purse seine catch rates of minor tunas in the Atlantic are close to 5% of the target tuna catch (Restrepo, 2011) and may be related to a combination of targeting minor tunas inshore areas by at least part of the fleet and a ready market available for the minor tuna catch.

7. Next steps

The second Phase of this project will be carried out in 2015, after developing and formalizing pilot projects. With the WCPO presenting the main challenge, there is a need to look more loosely at WCPO possibilities as first priorities for pilot projects. The study will continue the review of all aspects of the bycatch/small tuna situation in all areas, continue to collect as it becomes available in designated areas, noting that the situation is dynamic with developments and changes to CMMs and retention policy occurring continually. As well, it is necessary to collect more information on at-sea practices – storage, handling, retention/discards, onshore marketing mechanisms, and to encourage RFMOs to begin collect supply chain information on a routine basis.

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