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A review of potential options for managing swordfish taken as bycatch in longline fisheries

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Executive Summary

WCPFC16 requested that SC16 “consider a review (self-funded and developed by Australia, in consultation with interested CCMs) of possible measures and options relevant to the management of swordfish taken as bycatch in longline fisheries. The review may include information from available research and literature, logbook and observer data (in appropriately aggregated forms).” This request (in addition to a request for swordfish catch projections work at SC17) was made in recognition that the current measure for the Swordfish stock in the southern Convention Area (CMM 2009-03) does not contain the provisions required to ensure its future sustainability.

Subsequently, as detailed in this review paper, Australia has identified a range of potential “bycatch fishery” management options for consideration, including:

- Prohibition on Swordfish retention,
- Prohibition on *live or undersized* Swordfish retention,
- Fleet specific bycatch limits,
- Gear limitations, and
- Spatial and temporal combination options

In identifying the above options, we have also attempted to review any relevant research and sourced relevant regional longline logbook and observer data from WCPFC/SPC, including data pertaining to:

- Logbook based species catch proportions – to highlight areas where swordfish catch proportions are higher and any possible co-occurrence with target tuna species.
- Observer based data on the use of fishing methods known to increase swordfish catch rates (and therefore fishing mortality) including light sticks, squid bait and night setting.

The logbook and observer data are spatially aggregated to separate EEZ and high seas fisheries and so inform management options for high seas fleets in particular that take the majority of swordfish bycatch and which have no current restriction on fishing mortality under the current measure. It should be noted that the data summaries presented in this paper are preliminary and it is likely that WCPFC members will have further information and perhaps data to contribute. As such, this review can be considered preliminary and will be revised following feedback and discussion at SC16.

The key requirement of any swordfish bycatch management options that are selected for inclusion in a future revised CMM is that they are implementable, effective in achieving their objective (preventing significant future increases in fishing mortality by bycatch fleets), enforceable and avoid or minimise impacts on target tuna species catches for these fleets. Ideally these measures should be complimentary with existing measures and rely on MCS tools already in place.

In conclusion, Australia is seeking that SC16 review and provide feedback regarding:

- The likely effectiveness of the proposed measures in capping and preventing unrestrained increases in fishing mortality of swordfish in fleets taking this species as bycatch.
- Additional management options to consider in a future updated review.
- Additional information, research or data that would assist a future updated review.

This review will, alongside catch projections work scheduled for SC17, assist WCPFC consideration of a revised draft CMM in 2021.

Background

The issue

Swordfish in the south-west Pacific Ocean represents a currently healthy resource that has the potential to make a valuable future contribution to some WCPFC SIDS fisheries and is already an important component of some WCPFC member domestic fisheries. Currently, this potential is being undermined by a measure (CMM 2009-03 - Conservation and Management for Swordfish) that lacks provisions to ensure the ongoing sustainability of the stock. Specifically, the lack of any restrictions in the area north of 20°S (particularly the high seas), allows for unrestrained increases in fishing mortality. Flag based limits for the area south of 20°S place a cap on the number of vessels targeting Swordfish and catches of Swordfish (by flag). However, these limits may be too high to prevent future overfishing (when combined with increased northern catches) or to prevent sub-regional localized depletions. At WCPFC15 in 2018, Australia stated its intention to seek a Commission process to revise and strengthen the CMM.

Progress to date

In 2019, Australia consulted with and sought WCPFC member's feedback and inputs on this issue at subregional meetings and at WCPFC16. In December 2019, WCPFC16 considered a discussion paper ([WCPFC16-2019-DP19](#)), including the key concerns regarding the management of this stock and the high level principles identified by Australia for strengthening the CMM. The principles identified in the paper were for a future revised measure that would:

- apply in EEZs and high seas throughout the whole area of the stock (consistent with Article 3 and Article 5 of the WCPFC Convention).
- be reflective of our current best understanding of swordfish science and its assessed status.
- prevent further increases in fishing mortality on the stock to avoid future overfishing and an overfished stock (as per Article 5).
- accommodate subregional zone based management approaches and limits and ensure compatible management and limits on the high seas (as per Article 8).
- recognize the sovereign rights of coastal States to explore, exploit, conserve and manage HMS within areas under their national jurisdiction (as per Article 7).
- recognize the special requirements of, and avoid transferring a disproportionate burden of conservation upon, SIDS and Participating Territories (as per Article 30).
- seek the development of a consistent set of conservation and management measures for fish stocks that occur in both the WCPFC and IATTC Convention Areas (as per Article 22).

Following significant discussion between WCPFC members, where there was general agreement that the current measure requires revision and strengthening, WCPFC16 then:

- tasked the Scientific Committee in 2020 (SC16) to consider a review (funded/developed by Australia, in consultation with interested CCMs) of possible measures and options relevant to the management of swordfish taken as bycatch in longline fisheries.
- tasked the Scientific Committee in 2021 (SC17) to provide an evaluation of the long-term future of the southwest Pacific swordfish stock status under CMM 2009-03 based upon the latest SC-agreed stock assessment, utilising a range of future catch projections.
- requested the WCPFC Chair to write to the IATTC Chair to seek further assessment and CMM development and cooperation with the WCPFC in the management of the resource.

In response to the first WCPFC16 tasking (above), Australia has developed this review paper that identifies a range of potential "bycatch fishery" management options for consideration to strengthen CMM 2009-03. These potential options include:

- Prohibition on Swordfish retention,
- Prohibition on *live* or *undersized* Swordfish retention,
- Fleet specific bycatch limits,
- Gear limitations, and
- Spatial and temporal combination options

Scope of review

This review paper is in two parts:

- **Part 1** – provides a brief overview of global fisheries for swordfish including management approaches and stock status. This was undertaken to review how target and bycatch management approaches for this species have been enacted in other RFMOs.
- **Part 2** - focuses on identifying a range of potential management options for longline fleets taking swordfish as bycatch on the high seas north of 20°S (where there are currently no limitations to future fishing mortality levels for swordfish under the current measure).

Note that **Table 1** identifies the longline fleet catches for the period 2015-2018 and which fleets target or take swordfish as bycatch.

Request to SC16

This paper does not presume to be exhaustive in what options are available and Australia is seeking WCPFC members feedback and ideas in this regard. Australia is seeking that SC16 discuss and provide feedback regarding:

- The likely effectiveness of the proposed measures in capping and preventing unrestrained increases in fishing mortality of swordfish in fleets taking this species as bycatch.
- Additional management options to consider in a future updated review.
- Additional information, research or data that would assist the review.

This review will, once updated and when considered alongside catch projections work scheduled for SC17, assist WCPFC consideration of a revised CMM in 2021.

Part 1 – A brief review of global swordfish management approaches

Broadbill swordfish are a species that are targeted and/or taken as a significant bycatch in many “tuna” fisheries around the world. Management of this species has varied but it is clear that as a result of its biology and behaviour (longer lived, less productive, smaller stock sizes, and subregional fidelity and tendency to aggregate to seafloor features such as seamounts), it is a species whose stocks are typically less resilient to significant fishing pressure, and more susceptible to localised depletions, than many tuna species that these fisheries also target.

A number of regional swordfish fisheries around the world have gone through initial rapid expansion and then large declines, with failure in many of these being related to fleet overcapacity (Ward and Elscot, 2000 and Govender et al 2016). Currently both the Mediterranean and South Atlantic stocks are overfished. Management of some swordfish stocks is made more challenging due to a significant proportion of the swordfish being taken as an incidental catch from longline fleets targeting tuna and in some cases, blue sharks.

There are currently considered to be eight swordfish stocks globally that are managed by different Regional Fisheries Management Organisations (RFMOs), including:

- Indian Ocean Tuna Commission (IOTC) – Indian Ocean Stock
- Western and Central Pacific Fisheries Commission (WCPFC) – North Pacific and South-western Pacific stocks
- IATTC – North-eastern Pacific, South-eastern Pacific stocks
- ICCAT – Mediterranean Sea, North Atlantic, South Atlantic stocks

Tables 2 and 3 below provides a brief overview of these stocks and key management approaches taken with each. WCPFC, ICCAT and IOTC all have management measures that apply directly to swordfish, although the IOTC measures are not species specific unlike for ICCAT which has four measures specifically apply to Swordfish (IOTC, 2019 and ICCAT, 2019b). IATTC has no management measures that apply directly to Swordfish, although management measures that apply to tuna fisheries may also benefit Swordfish stocks (IATTC, 2019b).

Part 2 - Swordfish bycatch management options overview

The following sections outline each of five potential options for managing the take of swordfish bycatch in longline fisheries. Each option outlines a range of benefits and limitations (pro’s and con’s) associated with it. Australia has not at this stage attempted to provide recommendations on which options are most suitable for consideration in a strengthened CMM but will look to do that once we have received and considered feedback from SC16 and TCC16.

As a general observation, the potential effectiveness of a number of these options are yet to be fully assessed in light of available information and data relating to:

- At-haul life status (relating to post release mortality rates)
- Post release survival rates
- Size related trends in the above
- Gears and fishing methods currently used by longline fisheries in the stock area
- Existing monitoring and compliance mechanisms

In identifying bycatch fishery management options, Australia has also attempted to review any relevant research and sourced relevant regional longline logbook and observer data from WCPFC/SPC, including data pertaining to:

- Logbook based species catch proportions (**Figure 2**) – to highlight areas where swordfish catch proportions are higher and any possible co-occurrence with target tuna species.
- Observer based data on the use of fishing methods known to increase swordfish catch rates (and therefore fishing mortality) including light sticks (**Figure 4**), squid bait and night setting (**Figure 5**).

The logbook and observer data are aggregated into four spatial quadrants (**Figure 1**) covering the stock area and within each quadrant, into high seas and EEZs (combined). This approach recognises the need to present data in a way that can inform management options for fleets taking the majority of swordfish bycatch and which have no current restriction on fishing mortality under the current measure.

These preliminary information pertaining to species compositions, gears and fishing methods are presented (**Figures 2-4**) but will require further development and analyses. Further information on life status by area and fleet is also being sought by Australia.

Australia will continue to work and identify information and data relevant to strengthening these aspects of the review, including through feedback from the SC and TCC.

Option 1 - Prohibition of Swordfish retention

Description

This measure would apply a ban to the retention of Swordfish in fisheries where they are taken as a bycatch. Its intent is to prevent any targeting and maximise post release survival rates of fish taken as bycatch.

Examples

- Oceanic Whitetip Shark retention ban in all RFMO's with silky, thresher and hammerhead sharks banned in some RFMO's (Tototti et al, 2015).
- Black and blue marlin retention ban in Australian Commonwealth fisheries (FMA, 1991)
- Chinook salmon part and full season bans in some gillnet fisheries in Canada (PSC, 2004).

Key considerations

The effectiveness of this measure is dependent on the following factors:

- High proportion of live fish when hauled and high post-release survival.
- Practicality of adjusting fishing practices/gear changes to either improve the survival of the species at the point of landing or avoid capture of the prohibited species.
- Reliable and timely catch and discard monitoring and reporting

Where at-haul and/or post-release mortality are high, this measure would prevent targeting (i.e. prevent future *increases* in fishing mortality) but would not significantly *reduce* mortality of swordfish. Some research indicates that post-release survival for Swordfish is relatively high although studies have not been specifically conducted for bycatch fleets that use different fishing techniques to swordfish targeting fleets.

Recommendation

This management option would be most suitable in fisheries where:

- Swordfish make little economic contribution to fisheries profitability or economic sustainability,
- There is a high proportion of live fish when hauled and high post-release survival, and
- Vessels have appropriate monitoring (observers or EM) to ensure accurate data is available on the quantity and life status of fish discarded under this measure.

This measure can be considered for either full or partial application, for example in specific months or areas or in response to a catch trigger being reached. It should be noted that summaries of life status data, where available, will be included by fleet and area in an updated future review paper, to assist in consideration of the potential effectiveness of Option 1 and Option 2 (below).

Option 2 - No retention of live and/or undersized Swordfish

Description

This measure would apply a ban to the retention of **live** or **undersized** fish when hauled to the vessel, only allowing retention of dead fish or fish larger than the specified size limit.

Examples

- Porbeagle, shortfin mako and longfin mako sharks in Australia (Bruce et al, 2014).
- All sharks - Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) (Worm et al, 2014).
- Other RFMOs encourage the release of live sharks, especially juveniles that are caught incidentally and are not used for food and/or subsistence (CITES, 2014).
- Minimum size limits to protect juvenile Swordfish have been previously applied by ICCAT (Neilson et al, 2013)

Key considerations

Similar to the full retention ban option above, the effectiveness of this measure is dependent on the following factors:

- A relatively high level of on-board monitoring to ensure compliance with the measures.
- Reporting data being timely, reliable and accurate to enable analysis of interactions
- High proportion of live fish when hauled and high post-release survival,
- Vessel operators can adjust fishing practices/gear to either avoid capture of the species or improve the survival of the species at haul and after release , and

This option has a key advantage over option 1 where there is no waste fish that are bought to the boat alive, but it requires more at-sea monitoring to be effective. Where at haul and/or post release mortality are high, this measure would not result in any significant reduction of mortality of the prohibited species. Some research has indicated that post-release survival for swordfish is relatively high although studies have not been specifically conducted for bycatch fleets that use different techniques to targeted fleets.

The use of minimum size limits in isolation has been found to be inadequate in Swordfish fisheries (Ward et al. 2000). In the northern Atlantic case, the introduction of a minimum size regulation had little, if any, immediate effect on the rate of overfishing and the corresponding rate of depletion of the stock (Neilson et al, 2013).

Recommendation

This management option is most suited for fisheries that:

- Do not target swordfish but wish to maintain some economic benefit from the bycatch taken,
- Have a relatively high proportion of live fish at haul or low post-release mortality,
- Are able to modify fishing practices with minimal economic impact to improve the condition of fish upon hauling to maximise the change of post-release survival (e.g. the use of circle hooks), and
- Have appropriate monitoring to allow assessment of compliance with the measure.

In the case of minimum size limits, this option would be most suited to fisheries where the catch of juvenile fish is relatively low and juvenile fish are generally alive at haul and have a high rate of survival post-release. There is limited research on the post release survival of juvenile Swordfish at this time.

This measure can be considered for either full or partial application, for example in specific months or areas or in response to a catch trigger being reached.

Option 3 - Fleet specific bycatch limits

Description

This measure would impose a limit on the total number or weight of swordfish retained by a fleet that takes swordfish as a bycatch with the aim to cap or reduce fishing mortality of swordfish in that fleet. Generally these fleets are managed with either catch limits on the key target species (e.g. bigeye tuna) or by effort limits (e.g. days fished). Swordfish bycatch limit implementation options include catch measures (number, weight of fish, percentage of catch composition), effort limits (e.g. fishing days) at a number of temporal scales (e.g. trip, season/year).

Examples

Bycatch limits are one of the most commonly used tools to cap or reduce fishing mortality impacts in fisheries globally and there are many examples across fisheries and species. Examples relevant specifically to swordfish include:

- WCPFC imposes swordfish catch limits on bycatch (and target) fleets operating south of 20°S.
- ICCAT imposes bycatch limits for Atlantic Swordfish fleets via the swordfish recovery plan¹.
- IATTC imposes bycatch limits on silky sharks (IATTC, 2019)

Key considerations

The effectiveness of this measure is dependent on the following factors:

- Vessel operator's ability to adjust fishing practices/gear to avoid capture or improve post release survival if the limit is reached².
- High chance of survival for released fish to avoid unnecessary fishing mortality of discarded fish if limits are reached (Kerstetter and Graves, 2008 and Tolotti et al, 2015)³.
- Appropriate reporting and monitoring (port and on-board) is in place to ensure limits are adhered to, high-grading and discarding practices aren't occurring.

The adoption of catch limits for a bycatch species in fleets targeting tuna poses some challenges:

- If the limit is applied to retained catch, operators would be forced to discard fish once the limit is reached, reducing the measures effectiveness if mortality increased above agreed limits.
- If the limit was applied to total catch, it could act as a choke on catches of the target species and come at a very high economic cost.
- Limits may need to be non-transferable between north and south of 20°S, to avoid the occurrence of localised depletions in the either area that would seriously impact the

¹ Non-quoted entities were required to reduce catches by 45% of the reference year, except for entities with catches less than 100mt which couldn't increase above reference year amount (Neilson et al, 2013).

² A WCPFC study has also shown a reduction in swordfish bycatch after the introduction of fish only baits and circle hooks (Swimmer and Barcelo, 2018)

³ The available studies demonstrate that the post-release survival for Swordfish is relatively high in commercial fisheries, indicating that this measure could be effective. However, as discussed above these studies have not been undertaken specifically on fleets that take Swordfish as bycatch which may have different post release survival due to different fishing techniques.

economic viability of targeted fleets operating in those areas and future development opportunities of WCPFC SIDS.

Recommendation

This management option would prevent shifts to targeting swordfish by current bycatch fleets in the areas where this is applied and as such is most suited for fisheries that:

- Do not target swordfish but wish to maintain economic benefit from the bycatch taken,
- Are able to modify fishing practices to firstly, actively avoid catching swordfish once limits are approached/reached, and secondly to improve the condition of fish at point of hauling to maximise the chance of post-release survival (e.g. the use of circle hooks), and
- Have appropriate monitoring to allow assessment of compliance with the measure.

Consideration should be given to implementation of bycatch limits for bycatch fleets north of 20°S operating on the high seas (where a high proportion of total catch is taken), noting that bycatch limits were one of the measures implemented within ICCAT and contributing to the recovery of swordfish stocks in the Atlantic. At the current time, the healthy status of the stock offers an opportunity to set limits that would have little if any impact on catches of the target tuna stocks for those fleets in that area, but would prevent increases in swordfish catches in future to unsustainable levels⁴. Where catch limits are set at levels that don't impact target catches, any pressure on limits at the end of the season could be managed by temporarily adjusting fishing practices to minimise swordfish catches⁵.

The following analysis would assist with the consideration of this measure:

- analyses of recent fleet catch levels, catch composition and the prevalence of the use of fishing methods that significantly increase swordfish catches (as described under the *Gear Limitations* option) to improve understanding of the extent these measure are used and their impact on swordfish catches.
- understanding of post capture and discard mortality to determine the effect of such limits if imposed on retained catch only or if calculated to take into account likely discarding.

Option 4 - Gear limitations

Description

The banning or restriction of fishing methods and gear configuration designed specifically to target swordfish would aim to limit potential future increases in fishing mortality on this species by fleets that currently take swordfish as bycatch and do not currently use these methods. In the central/southern Pacific, longliners targeting swordfish (Beverly et al, 2003; Campbell, 2003, Murray and Griggs, 2003, Nguyen and Winger, 2019; Ward and Elscot, 2000; Bigelow, 2006; NOAA, 2005; EU, 2011) will typically:

- Use lightsticks, squid bait, and afternoon/night setting,
- Set gear shallow to target the mixed layer (mainline set close to the surface with short floatlines, shorter branchlines, few branchlines between floats ~3-10)
- Target seafloor features (seamounts, canyons, ridges, rises) or strong ocean temperature fronts/convergences/eddies.

⁴ Any development of total and fleet specific catch limits should be done in association with projections on the current stock assessment model to demonstrate that the total limits are sustainable. Where objectives for the stock extend to economic/social outcomes, such projections can help to assess the implications of catch limits for achieving those objectives also.

⁵ This is common practice by fishers in the Australian fishery who each have individual allocations of target species. They adjust their fishing gear, areas and approaches depending on how close to their catch limit they are, to reduce catches of limiting species and increase catches of other species.

- Target the period on or close to the full moon.

Examples

No examples could be found of jurisdictions that restrict fishing methods/gear use to specifically cap (and prevent targeting) or reduce fishing mortality of swordfish. Australia would welcome advice from other WCPFC members if they are aware of relevant examples. There are many examples of fishing method/gear restrictions to reduce fishing mortality of other retained bycatch/byproduct species such as for sharks (e.g. wire trace, shark line restrictions in WCPFC), turtles (e.g. circle hooks) and marlin (e.g. hook number per shot in Australian fishery in the Coral Sea area).

Key considerations

Implementation Issues

Ideally, management measures aimed at capping or reducing catches of a bycatch species should not impact on a fleet's ability to target or catch the primary target species. While there is strong evidence that the swordfish targeting methods noted above significantly increase the catch rates of swordfish (Nguyen and Winger, 2019 and Murray and Griggs, 2003), it needs to be understood if restrictions on or the banning of any of these techniques would impact fleets targeting tuna species.

Table 2 indicates that approaches to targeting swordfish generally differ in clearly identifiable ways from those for targeting yellowfin and albacore tuna (different set times, no lightsticks, different bait). However this may not always be the case for bigeye tuna which, while often targeted in deep waters during day sets, can also be targeted in a manner similar to swordfish (i.e. shallow at night around the full moon, including using squid bait and lightsticks).

Figure 2 indicates that in the swordfish 'bycatch' fishery operating in the north-east quadrant high seas, swordfish bycatch levels are higher in association with fleets that have a higher proportion of bigeye tuna in the catch. Conversely, albacore tuna fisheries or albacore/yellowfin fisheries often have very little swordfish bycatch.

Further information is needed to assess the implications of potential restrictions on gears/methods (associated with swordfish targeting) for tuna targeting fleets, including:

- firstly, summaries of fishing gear/method (e.g. time of set, bait, light stick use etc.) and catch composition data, from observers and/or logbooks; Preliminary observer data obtained from WCPFC/SPC are provided to indicate possible fleet and area trends in light stick use (**Figure 4**) and time of day of setting (**Figure 5**). For use of squid bait, WCPFC/SPC regional observer data indicate only one "bycatch" fleet/CCM (Chinese Taipei) using squid bait. Another factor that could be explored is depth of setting, often proxied by hooks per float. Any interpretation of longline observer data will need to take into account the coverage levels (typically very low on the high seas) and representativeness of such data.
- secondly, assessment of existing CPUE models regarding the potential effect of such restrictions on swordfish bycatch rates. A key challenge in undertaking the above may be the availability of detailed fishing method information (OFP, 2015) for the key fleets. Depending on the outcomes of the above actions, it may be possible to consider integrating "bycatch" conditions into the CMM based on either individual gear parameters (e.g. lightsticks use) or combinations of parameters (e.g. lightsticks, squid bait and night setting). These could be further targeted to specific areas and seasons if appropriate.

Compliance Monitoring Issues

The inclusion of any gear or fishing method related restriction within the WCPFC would only be appropriate if sufficient monitoring was in place to verify compliance. MCS requirements would be dependent on what fishing techniques were prohibited and whether the presence of the gear was prohibited on vessels (Table 3). For example, if the carriage of lightsticks or squid bait was

prohibited, then compliance options would include pre- and post-trip and at-sea vessel inspections. If the use of these gear/bait were only restricted under certain circumstances (e.g. fishing at night) then a higher level of on-water monitoring would be required to ensure compliance. Other measures, e.g. restrictions on night fishing, could potentially be monitored by VMS/AIS. Analytical methods, for example comparing catch composition of vessels with and without observers (or EM), is another potential compliance monitoring tool.

Recommendation

Further information on the fishing methods and catch composition of the key swordfish bycatch fleets in the area of the SWPO stock, would assist in understanding the potential use of and implications of a gear/method based condition in the CMM.

The restriction or banning of the use of one or a combination of the following factors - lightsticks, squid bait and/or night setting - is an appropriate measure for swordfish bycatch fleets that do not use this combination of fishing methods to target bigeye tuna. The measure would act to limit potential future increases in fishing mortality of swordfish by these fleets, but would not necessarily reduce current fishing mortality.

For fleets that do use this combination of methods to target bigeye tuna, consideration could be given to partial limitations – e.g. day setting only, fish bait only, or no lightsticks – or to applying this measure when approaching a trigger catch level of swordfish.

Compliance monitoring and verification would depend on the specific measure used (see discussion above).

Option 5 - Spatial, Temporal and Combined Management Options

Description

There are a range of combinations of the bycatch management options described above that may provide more effective and acceptable options for managing swordfish bycatch in the stock area, than might any single option considered in isolation. Furthermore, the addition of specific spatial or temporal elements to those options can help to refine and focus their application. Some examples of combined management options are provided below. This list is not intended to be exhaustive.

Examples

- Non-retention or live only retention for:
 - specific times/areas or
 - when a catch trigger is reached.
- Restrictions on fishing methods for specific season/areas (e.g. spawning or aggregation areas) or when a catch trigger is reached. Similar to the FAD closure concept, this could be a prohibition in the key bycatch areas on the use of, for example, lightsticks or night setting, in a particular period of the year.
- Non-retention combined with gear limitation – for example non-retention would be more effective in combination with the use of circle hooks, which have demonstrated increased survival at haul and reduced post release mortality (Kerstetter and Graves, 2006, Carruthers et al, 2009 and Reinhardt et al, 2017).
- Effort limits with gear/bait restrictions – where fisheries are imposing effort based limits to manage target species catches, these could be combined with gear and bait restrictions (e.g. no use of lightsticks, no night sets and/or no squid baits) to ensure that effort is not directed at swordfish.
- Spatial/Temporal closures – Large spatial temporal closures are usually only applied when stock status is poor, for example, fishery/area closures imposed on swordfish fishing by

ICCAT (ICCAT, 2019) in the Mediterranean and the US in the past in the Texas/Florida/Gulf of Mexico area (Ward et al, 2000). The tendency of this species to aggregate around seamounts might suggest the potential to explore smaller exclusion areas.

The effectiveness of any combined measures in achieving the objective (of preventing future increases in swordfish fishing mortality in these fleets) would need to be examined using available research and data.

Conclusion

There is a general recognition (discussed at WCPFC16) that the current measure for the Swordfish stock in the southern Convention Area (CMM 2009-03) does not contain the provisions required to ensure its future sustainability. A precautionary approach dictates that the measure is revised and strengthened now, while the stock is still healthy, to ensure it remains healthy in future. There are a range of elements in the current measure that require review and strengthening, with one of these being the management of bycatch of swordfish on the high seas, which accounts for a high proportion of overall fishing mortality on the stock.

This paper is a preliminary review of potential options for strengthening the provisions of CCM 2009-03 for managing swordfish taken as bycatch predominantly on the high seas in the southern swordfish stock area. The options are presented to promote discussion and may not represent the full suite of feasible and effective options. The paper will continue to be developed as relevant data and available/historic research findings are identified and integrated, and to take into account consultations with and inputs from WCPFC members. Further analyses of fishery wide and fleet level logbook and observer data will assist proper consideration of the likely effectiveness of many of the above options.

The key requirement of any options chosen to include in a future revised CMM is that they are implementable, effective in achieving their objective (preventing significant future increases in fishing mortality by bycatch fleets), enforceable, and wherever possible minimise impacts on target tuna species catches. Ideally these measures should be complimentary with existing measures and rely on MCS tools already in place.

Request to SC16

This paper does not presume to be exhaustive in what options are available and Australia is seeking WCPFC members feedback and ideas in this regard to inform its planned work to develop a more effective Swordfish CMM for adoption by the Commission in 2021. Australia is seeking that SC16 discuss and provide feedback regarding:

- The likely effectiveness of the proposed measures in capping and preventing unrestrained increases in fishing mortality of swordfish in fleets taking this species as bycatch.
- Additional management options to consider in a future updated review.
- Additional information, research or data that would assist the review.

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Table 1 – Catches of Swordfish (2016-18) by flag within the WCSPO Swordfish Stock Assessment area (Regions 1 and 2 combined) . Source – SPC 2019. For each flag/fleet, the assumed status of swordfish as bycatch or target species is indicated. Asterisk (*) indicates uncertain or past low level targeting.

Flag	2016	2017	2018	Total	% of Total Catch	Status
AU	1162	1066	854	3082	13.4	Target
CK	23	56	26	105	0.5	Bycatch*
CN	1289	1574	1481	4344	18.9	Bycatch
ES	1651	932	1123	3706	16.1	Target
FJ	141	117	105	363	1.6	Bycatch*
ID	640	3	3	646	2.8	Bycatch
JP	414	287	355	1056	4.6	Bycatch
KR	362	356	634	1352	5.9	Bycatch
NC	8	22	8	38	0.2	Bycatch
NZ	755	504	463	1722	7.5	Target
PF	100	147	218	465	2.0	Bycatch
PG	6	6	21	33	0.1	Bycatch
SB	0	0	55	55	0.2	Bycatch
TO	39	32	44	115	0.5	Bycatch*
TV	3	12	2	17	0.1	Bycatch
TW	1618	1815	1425	4858	21.1	Bycatch
US	50	55	47	152	0.7	Bycatch
VU	118	411	360	889	3.9	Bycatch
WS	4	16	11	31	0.1	Bycatch

Table 2: Summary of Swordfish status and management in WCPFC

	North Pacific (ISC Billfish Working Group, 2018)	South Western Pacific (Takeuchi et al, 2017)
Recent Average Catches	10,489t (2010-2016) 10,068t (2016)	~ 8,000mt
Peak Historic Catch	22,000t (1960) and 19,000t (1993)	~ 11,000mt
Recent Depletion	$SB_{2016}/SB_{MSY} = 1.87$	$SB_{recent}/SB_{MSY} = 1.58 (1.02 - 3.1)$ Median $SB_{latest}/SB_{F=0} = 0.35 (0.27 - 0.44)$
Recent F	$F_{2013-2015} = 0.08, F_{MSY} = 0.17$	$F_{2011-2015}/F_{MSY} = 0.86 (0.42-1.46)$
Stock Status	Not likely overfished and is not likely experiencing overfishing relative to MSY or SB20% based reference points	Not overfished and overfishing not occurring relative to MSY or 20% SSB _{F=0} based reference points
Management Measures	No direct measures	Limitation of fishing capacity (vessels), maximum total catch south of 20°S (based on reference years), record of Swordfish vessel numbers.

Table 3: Summary of Swordfish status and management in other Regional Fisheries Management Organisations

	ICCAT (ICCAT, 2019a)			IATTC		IOTC
	North Atlantic	South Atlantic	Mediterranean	North East ⁶ (Ji-Yih Yau et al, 2014)	South East (Hinton and Maunder, 2011 and IATTC, 2019c)	(IOTC, 2018, IOTC, 2019a and Williams et al, 2019)
Recent Average Catches	11,245t* 2018 – 8,858t *av. last 10 years, inc. discards	10,877t* 2018 – 10,404t	10,252t* 2018 – 7,079t	26,007 (last 10 years, EPO, all methods) 2017 – 21,400 t (LL), 6,285 t (OTH), 27,688 (TOTAL)		27,849t (last 10 years, all methods) 2017 – 34,782t
Peak Historic Catch	20,238t (1987)	21,930t (1995)	20,365t (1988)	31,890t (2015) – all methods 25,805 (2015) – LL		<40,000t (2004)
Recent Depletion	$B_{2015}/B_{MSY} - 1.04$ (0.82 - 1.39)	$B_{2015}/B_{MSY} - 0.72$ (0.53 - 1.01)	$B_{2015}/B_{MSY} - 0.12$	$EPO - B_{2012}/B_{MSY} - 1.89$ (1.34 – 2.44)	$B_{RECENT}/B_{MSY} - 10.40$	$SB_{2015}/SB_{MSY} - 1.50$ (1.05–2.45)
Recent F	$F_{2015}/F_{MSY} - 0.78$ (0.62-1.01) $F_{MSY} - 0.17$ (0.10-0.27)	$F_{2015}/F_{MSY} - 0.98$ (0.70 - 1.36) $F_{MSY} - 0.28$ (0.17-0.44)	$F_{2015}/F_{MSY} - 1.85$ $F_{MSY} - 0.25$	EPO - N/A	$C_{RECENT}/MSY - 0.57$	$F_{2015}/F_{MSY} - 0.76$ (0.41–1.04)
Stock Status	Not overfished and no overfishing occurring (2015) ⁷	Overfished with no overfishing occurring (2015) ²	Overfished and overfishing occurring (2015) ⁸	Not overfished and no overfishing occurring (2014 and 2018)	Not overfished and no overfishing occurring (2011)	Not overfished and not subject to overfishing (2017)
Management Measures	Direct TAC (2018-2021): 13,200t Minimum size limit	Direct TAC (2018-2021): 14,000t Minimum size limit	Direct 3 month closure, hook and gear limits, minimum size limit, fishing capacity restrictions, TAC 10,185t (2018 with 3% annual reduction)	Direct No measure for SEPO stock Indirect Limitation of fishing capacity, use of the Best Available Science, HCR for Tropical Tunas, Closures, FADs limitation, catch limits for Bigeye	Direct No direct measures (IOTC, 2012). Indirect Move towards a quota system for key species (inc. Swordfish), record of Swordfish vessel numbers and fishing capacity of vessels <24m and MSY-based target and limit reference points key species (IOTC, 2012).	

⁶ There are two assessments undertaken that cover the North East Stock, an 2018 assessment of the WCNPO that included data across RFMOs (including IATTC) and the 2014 assessment of the EPO within the IATTC area.

⁷ The current 2015 assessment indicates that the North and South Atlantic Stocks are close to B_{MSY} and lower than B_{MSY} respectively. However, some important uncertainties in the assessment should be noted: mortality does not account for unreported dead and live discards; quota carryovers and quota transfers across the North and South stocks are not accounted for and the total cumulative quota allocation across the North Atlantic is above the TAC if fully caught.

⁸ There is uncertainty in this assessment - the level of the stock to be rebuilt is contingent on the assumption on future recruitment which is highly uncertain. Increased monitoring of landing and discards is required reduce this uncertainty and better understand the changes to discard since the establishment of minimum catching sizes.

Table 4 – Preliminary draft of characteristics of pelagic longline sets and possible monitoring tools in the tropical and southern Pacific targeting swordfish and different species of tuna (Sources: Beverly et al, 2003). *To be developed further* – Australia is seeking information from WCPFC CCMs on the use of different fishing approaches (listed below) in targeting tuna and swordfish. Some information is available via submitted observer and logbook data but coverage and representativeness of that data is uncertain.

Method	Method category	Swordfish	Bigeye Tuna	Yellowfin Tuna	Albacore Tuna	Possible compliance tools
Bait	Squid	X	X?			Port and at sea inspection, Observers, EM
	Fish		X	X	X	
Light sticks		X	X?			Port and at sea inspection, Observers, EM
Hooks per float	3 to ~10	X	X (night)	X		Observers, EM
	More than 10		X (day)		X	
Floatline and branchline lengths	Shorter	X	X (night)	X		Observers, EM
	Longer		X (day)		X	
Time of setting (and soaking)	Afternoon/Evening (Night)	X	X			VMS, AIS, Observers, EM
	Morning (Day)		X	X	X	
Moonphase Importance	Catch higher near full moon	High	Moderate	Moderate/Low?	Low?	na

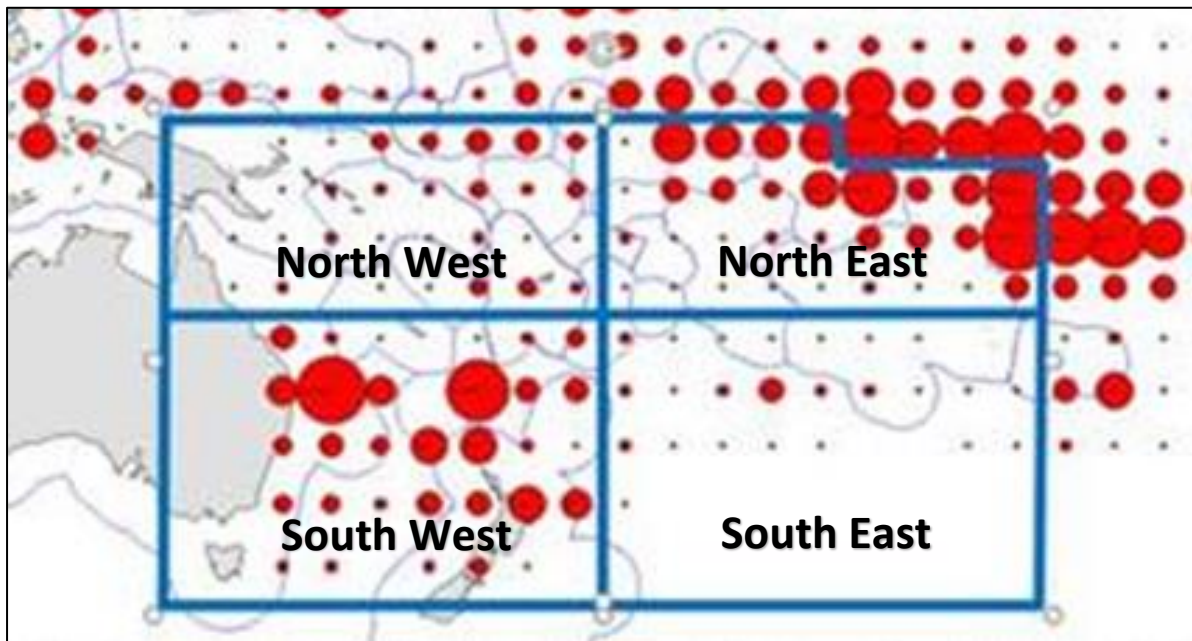


Figure 1 - Swordfish catches (red circles, scaled to level of catch) by 5 degrees in the Pacific Ocean for the period 2015 – 2018. The blue box defines the four sub-regions into which the following data summaries for this paper are divided. For each subregion (North West, North East, South West, South East) the data summaries in this paper aggregate the data into two additional areas being EEZs and High Seas – and then within each by flag. (Source: SPC, 2019)

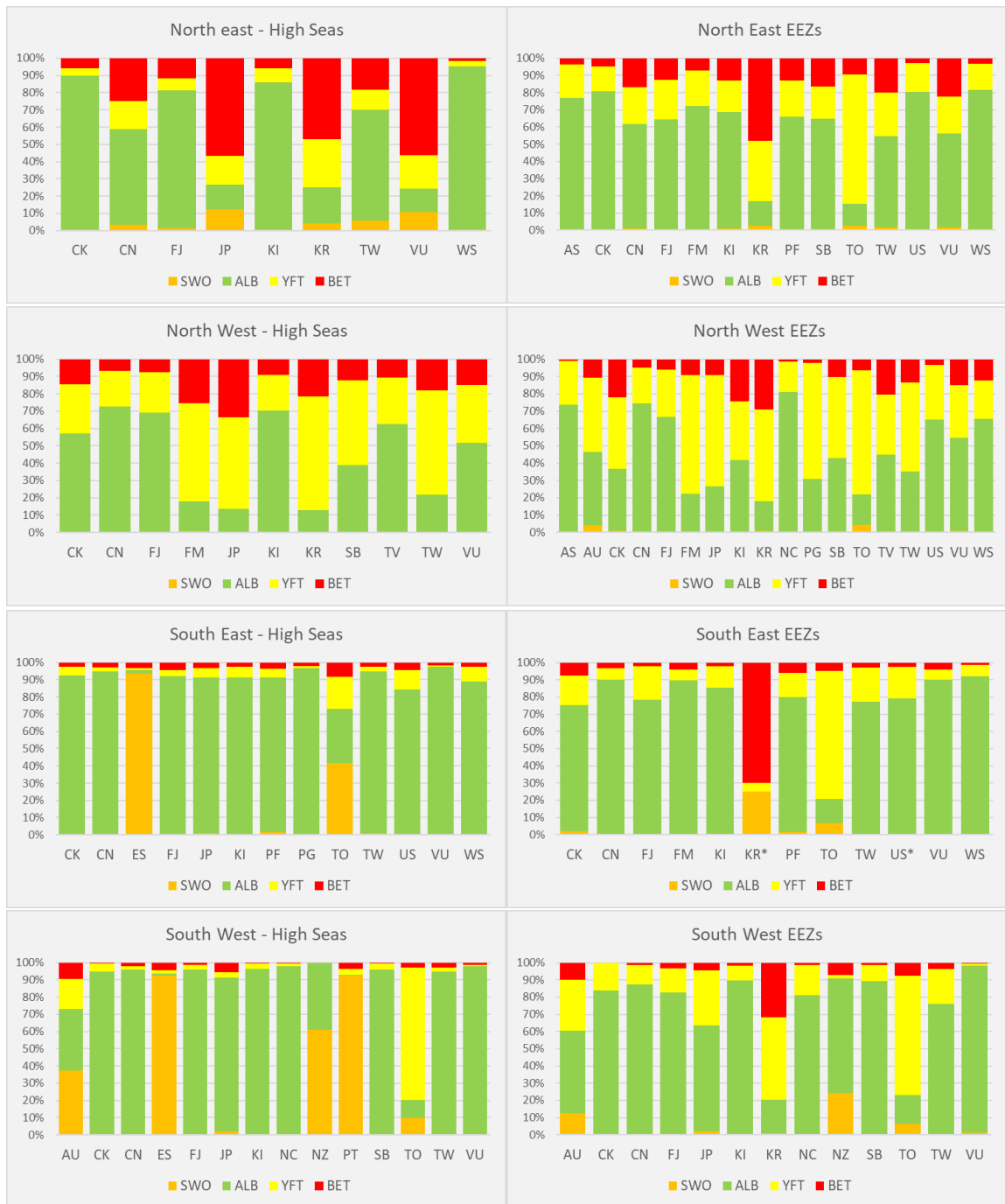


Figure 2 – Species catch proportions (based on number caught) as recorded in logbooks – for data aggregated by quadrant (north east, north west, south east, south west) and within quadrant, high seas or inzone, and by flag. Note that the number of sets reported on logbooks is highly variable across quadrants and flags (Source – SPC 2020).

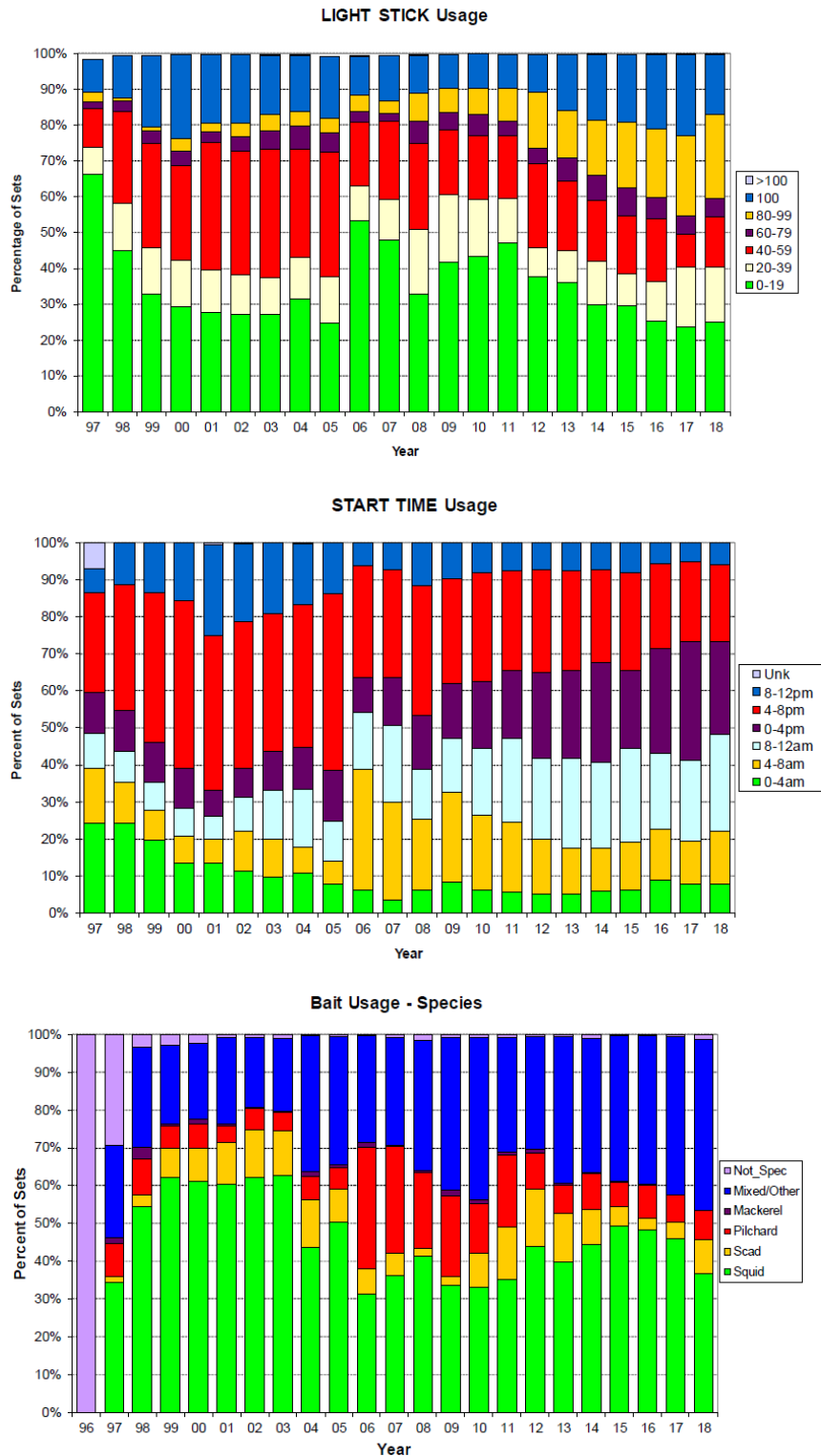


Figure 3 – An example (using the Australian longline fleet logbook data) of the type of information that can assist in helping to understand the potential use of different bycatch management options. Shown above are the proportion of total sets fished that (top) use different amounts of lighsticks, or (middle) are set at different times of day or night, or (bottom) use different bait type. Note that lighsticks, afternoon/night setting and squid bait – are fishing methods likely to increase swordfish catch rates (they are used by swordfish targeting fleets).

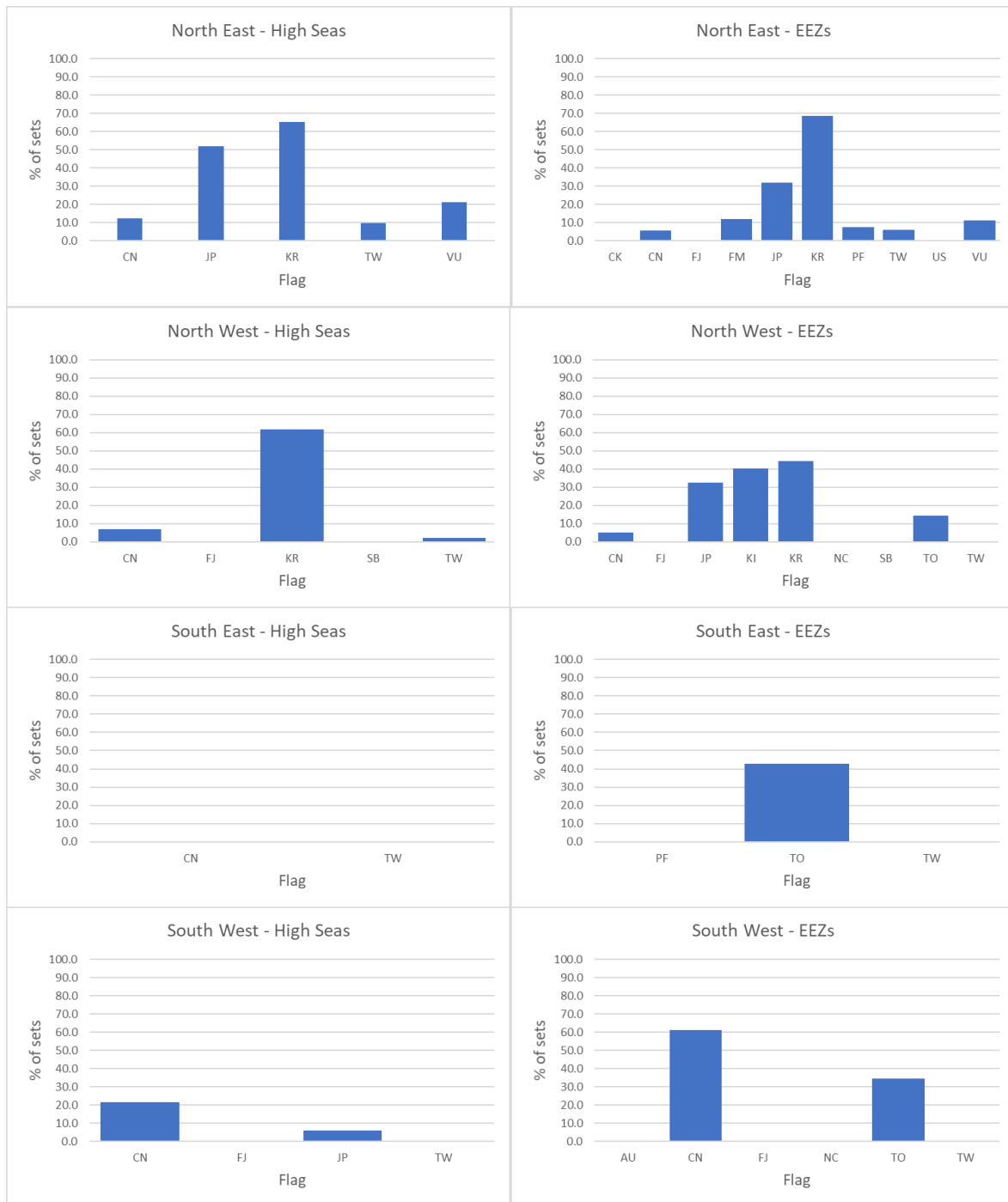


Figure 4 – The percentage of *observed* longline sets using light sticks – for observer data aggregated by quadrant (north east, north west, south east, south west) and within quadrant, high seas or inzone, and by flag, based on observer data for the period 2015-2019 (Source SPC, 2020). This information is presented as a preliminary example of the type of information that may assist WCPFC members to assess the implications of different bycatch management options for their fishery/fleets. Note that only data pertaining to area-flag strata comprising more than 3 vessels are represented, and the number of sets observed and the coverage (and representativeness of those sets of the broader flag fleets) varies significantly.

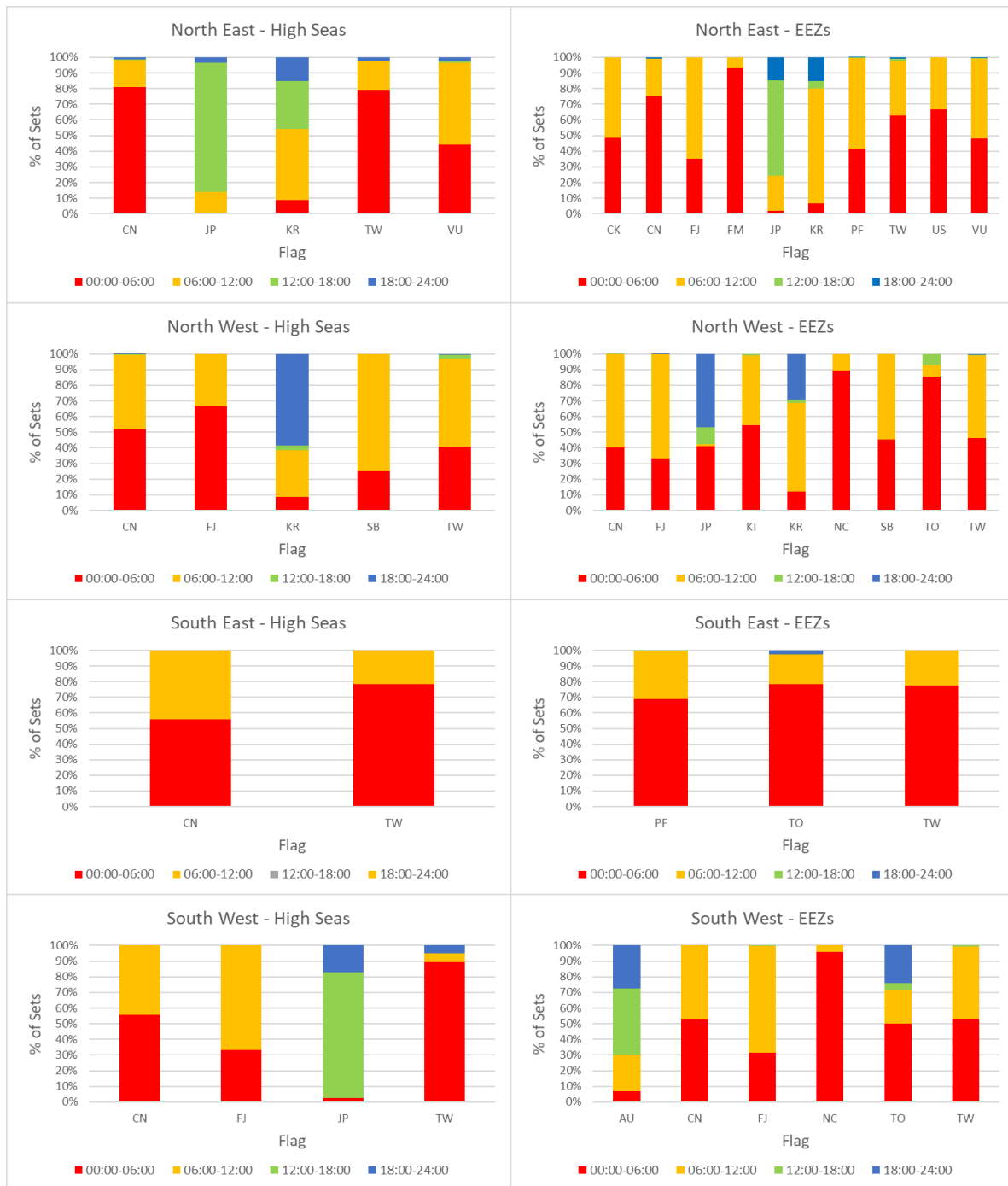


Figure 5 – The percentage of *observed* longline sets by time of day of setting, aggregated by area and flag, based on observer data for the period 2015-2019 (Source SPC, 2020). This information is presented as a preliminary example of the type of information that may assist WCPFC members to assess the implications of different bycatch management options for their fishery/fleets. Note that only data pertaining to area-flag strata comprising more than 3 vessels are represented, and the number of sets observed and the coverage (and representativeness of those sets of the broader flag fleets) varies significantly.