WCPO Purse Seine Tuna FIP (Thai Union)

Updated ETP and Ecosystem Scoring

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Final V1.0

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Introduction

The FIP is made up of a fleet of tuna purse seine vessels, flagged to Taiwan, Republic of Korea, the United States, Kiribati, Nauru and the Federated States of Micronesia (FSM). The vessels fish in the WCPO for the three tropical tuna species (with most of the catch being made up of skipjack). They deploy Fish Aggregation Devices (FADs), and fish on FADs and other floating objects, as well as setting on free schools.

The free-school composite of the fishery generally scored well against the P2 Performance Indicators (PIs), which reviews the interactions/impacts of the UoA with the marine ecosystem including associated species, endangered, threatened and protected (ETP) species and the habitat. The majority of scores align with the Public Certification Report (PCR) from the most recent re-assessment of the PNA free-school fishery (Blyth-Skyrme et al., 2018). Although the pre-assessment perceived an issue with whale shark interactions in both the free-school (and FAD-associated fisheries), which was not shared by the PNA free-school assessment. This could be attributed to lack of fishery-specific data, so the scoring applied was in the pre-assessment was precautionary.

For the FAD-portion of the fishery, scorings are aligned with the OPAGAC FIP and includes unobserved mortality of ETP species due to FAD entanglement and ecosystem impacts of FADs. The former only applies if entangling FADs are used, but it is thought that this may be the case in this fishery. Entanglement in FADs is an issue for a range of species, but principally, it is thought, silky sharks (Filmalter et al., 2013) and turtles.

The MSC definition of an ETP species is:

- Any species that is recognised by national ETP legislation.
- Species listed in the binding international agreements given below:
    - Appendix 1 of the Convention on International Trade in Endangered Species (CITES), unless it can be shown that the particular stock of the CITES listed species impacts by the UoA under assessment is not endangered.
    - Binding agreements concluded under the Convention on Migratory Species (CMS), including:
        - Annex 1 of the Agreement on Conversation of Albatross and Petrels (ACAP).
        - Table 1 Column A of the African-Eurasian Migratory Waterbird Agreement (AEWA).
        - Agreement on the Conservation of Small Cetaceans of the Baltic and North Sea (ASCOBANS).
        - Annex 1, Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS).
        - Wadden Sea Seals Agreement.
        - Any other binding agreements that list relevant ETP species concluded under this Convention.

- Species classified as 'out of scope' (amphibians, reptiles, birds and mammals) that are listed in the IUCN Redlist as vulnerable (VU), endangered (EN) or critically endangered (CE).

This document updates the ETP, and ecosystem scoring based on the collection of observer data of ETP species the fishery interacts with and new updated MSC assessments.

Table 1. Summary of Principle 2 Performance Indicator level scores – WCPO

Performance Indicator	Draft scoring range	Data deficient?
2.3.1 – ETP Outcome	**60-79**	**No**
Rationale or key points		
There are no national and/or international catch limits for ETP species that apply to tuna RFMO fisheries in the WCPO therefore PI 2.3.1-a is considered not relevant. The International Whaling Commission (IWC) has established catch limits that apply only to fishing operations (factory ships, land stations, and whale catchers) targeting whales (https://iwc.int/convention). As no MSC UoA fisheries target whales, and targeting of cetaceans is prohibited by RFMOs, the established IWC catch limits to not apply. While there are domestic regulations at the flag level that prohibit the retention of ETP species (e.g., US Marine Mammal Protection Act), within assessments they are not viewed as established catch limits. Rather, they are mandates on fishing operations. ETP species interactions in the WCPO included sharks, cetaceans, sea turtles, and mobulids (see Appendix for full catch. Information on the ETP species interactions were provided for all UoA vessels and based on observer information all animals were discarded. Percentages caught by the UoA are all low, 0.05% of the total catch. The following species have been assessed due to their conservation importance with management and position in the ecosystem. ***Silky Shark*** Following the most recent stock assessment of silky shark for the WCPP-only (Common Oceans (ABNJ) Tuna Project 2018b) the WCPFC-SC concluded that silky sharks were subject to overfishing (fishing mortality is 1.6 times the MSY fishing mortality) in the WCPO but were likely not to be in an overfished state (Pr (SB2016 > SBMSY) = 72%) (WCPFC-SC 2018a). Therefore, rebuilding of silky sharks is not required. Clarke et al. (2018) undertook a Pacific-wide stock assessment for silky shark and estimated the total catch of silky shark based on trade-based catch records to be around 38,000 t, annually. In comparison, average annual catches in the fishery are 0.04% of the total. Noting silky shark is the main bycatch species in WCPO FAD sets the fishery implemented further mitigation measures by applying Best Practices for safe handling and release of sharks and rays brought onboard as described in Chapter 3 of the ISSF Skipper's Guidebook. The small catches, compliance with existing non-retention measures, and application of best handling and release measures provides a high degree of confidence that 'known direct effects of the fishery are highly likely to not hinder recovery of silky shark if required; SG60 and SG80 are met. **Oceanic Whitetip Shark** The most recent assessment of WCPO oceanic whitetip shark was conducted in 2019 and while most model runs predicted SB/SB0 to be below 0.05, all model runs predicted SB/SB0 to be below 0.1 (Tremblay-Boyer et al. 2019). F/FMSY is predicted to have declined by more than half from 6.12 to 2.67 (median) for the last year of the assessment (2016) following the adoption of conservation measures to protect oceanic whitetip shark (CMM2011-04). Despite the reduction in fishing mortality depletion levels remained very low over all grid runs (median: 0.0367, 95%CI: 0.021–0.061). Average annual catches of oceanic whitetip shark in the fishery are relatively small, contributing 0.0004%. The total catch of oceanic whitetip shark in all WCPO		

fisheries is estimated to range from a few thousand to several hundreds of thousands of individuals (Tremblay-Boyer et al. 2019) and comparing this to the catch by the fishery provides a high degree of confidence that the fishery is highly likely to not hinder recovery of oceanic whitetip shark in the WCPO. On this basis SG60 and SG80 are met. Similar to silky shark, there is likely to be an unobserved level of post release mortality, as well mortality due to animals entangled in FADs. All vessels operating in the WCPO are deploying the low-entanglement FADs as specified under CMM 2018-01, but we do not have information on entanglement rates. While we consider this unobserved mortality to not pose a significant risk to oceanic whitetip shark it is not possible to confirm this with a high degree of confidence and on this basis SG 100 is not met.

Whale Shark
Stock status for the Indo-Pacific whale shark was assessed by Rice and Harley (2012) and recently by Neubauer et al. (2018) in a risk-based framework based on information from all purse seine fisheries in the Pacific Ocean. Results from the risk-based analysis indicated that the risk of exceeding three F-based limit reference points was generally less than 20% since 2009 and concluded that the risk from Pacific Ocean purse seine fisheries in aggregate is moderate to low. Average annual whale shark interactions in the fishery are relatively small, approximately 0.0003% per year and all animals were discarded alive. The impact of the fishery on the Indo-Pacific whale shark population is therefore considered to be negligible and requirements at the SG 60, SG 80, and SG 100 levels are met.

Sea Turtles
In the WCPO both the species composition and number interactions was higher in FAD sets compared to free schools sets. Interactions in sets included green, hawksbill and loggerhead. Regardless of set type green turtles were caught the most. This species comprised 0.00003% of the total UoA catch, which represents a very small portion of the catch. The fishery undoubtedly comprises a negligible catch on these species.

The status of turtles encountered by fisheries in the WCPO have not been specifically examined by WCPFC. Currently it is estimated that approximately 116,000 nesting female green turtle occur in the Pacific Ocean (Seminoff et al., 2015). Approximately 11,725 nesting female hawksbill turtles occur in the Pacific Ocean (NMFS and FWS, 2013). It is estimated that approximately 9,200 nesting female loggerhead turtles (https://www.fisheries.noaa.gov/species/loggerhead-turtle), and 4,000 nesting female leatherback turtles (Benson et al., 2015) occur in the Pacific Ocean. All sea turtle species are currently listed as vulnerable, endangered, or critically endangered by the International Union for Conservation of Nature (IUCN. Based on the low number of turtle interactions, the near 100% observer coverage of UoA fishing operations, the release of all turtles, meets the SG 60 and SG 80 levels. There is the potential for an unobserved level of mortality due to turtles entangled in FADs. All vessels operating in the WCPO are deploying the low-entanglement FADs as specified under CMM 2018-01, but we do not have information on entanglement rates. While we consider this unobserved mortality to not pose a significant risk to WCPO turtle populations it is not possible to confirm this with a high degree of confidence and on this basis SG 100 is not met.

Mobula
In the WCPO, mobulid interactions were with M. birostris and unidentified mobula and mantas. In sets, catches of unknown mobulids were the third highest of ETP species caught at 0.001% of the total catch, which represents a very small portion of the total catch. The population size of the giant manta rays and devil rays is difficult to assess, but abundance trajectories have been estimated based on long time series of sightings at diving sites. Locally, abundance varies substantially and may be based on food availability and the degree that they were, or are currently, being fished (https://www.iucnredlist.org/species/198921/68632946#threats). In most regions, Giant Manta Ray population sizes appear to be small ranging from 100 to 1,500 individuals (https://www.fisheries.noaa.gov/species/giantmanta-ray). Photo-identification studies at specific aggregation sites have yielded minimum estimates of 42 to 500 individuals over almost a decade of monitoring in most locations, including: Mozambique, Thailand, Myanmar, Indonesia (Holmberg and Marshall 2018), Japan (Kashiwagi et al. 2010), Brazil (Luiz et al. 2008), and Mexico (Rubin 2002). A 6-year study has catalogued more than 2,000 individuals in a single site, off mainland Ecuador (Holmberg and Marshall 2018). The trend of the number of individuals varies widely across the range of the Giant Manta

Ray, but trends appear stable where they are protected and declining rapidly where fishing pressure is greater (Ward-Paige et al. 2013; Holmberg and Marshall 2018). Unidentified Mobula and Mantas is a bycatch component of many small and large-scale fisheries, with much of this catch being aggregated across multiple devil ray species. The lack of comprehensive species-specific catch, fishing effort, and population data necessitates the use of genus-wide inferences to assess population reductions and based on a combination of declining sightings-per-unit-effort (SPUE) data from monitored populations, catch landings data, and evidence of depletions, significant population declines have been inferred (Fernando and Stevens 2011, Couturier et al. 2012, Hall and Roman 2013, Ward-Paige et al. 2013, Lewis et al. 2015, Croll et al. 2016, Rohner et al. 2017). In areas where catch data is available population declines of 50-99% over the last three generations (38 years; from 1980-2018) has been inferred, with a further population reduction suspected over the next three generation lengths (2018–2056). Between 2000 and 2007, total landings of Giant Manta Rays and devil rays increased from 900 mt to over 3,300 mt according to the FAO Fishstat Capture Production database (Lack and Sant 2009). This equates to an average of 1,593 mt being landed per annum with this average increasing to 4,462 mt per annum from 2008 to 2017 (Oakes and Sant 2019). In 2018, reported catches of Giant Manta Rays in the western Pacific Ocean was estimated at 201 mt. Based on observer data from the UoA the annual catch of Giant Manta Rays was estimated at 6 mt, which accounts for approximately 3% of the annual western Pacific Ocean catch. Reported catches of devil rays from the western Pacific Ocean in 2018 is estimated at 5,500 mt, while the reported annual catch by the UoA is estimated at 2 mt, accounting for approximately 0.04% of the annual western Pacific Ocean catch. We note that CMM 2019-05, Conservation and Management Measure on Mobulid Rays Caught in Association with Fisheries in the WCPFC Convention Area, which enters into force on January 1, 2021, stipulates that:

- CCM vessels are prohibited from retaining on board, transhipping, or landing any part or whole carcass of mobulid rays caught in the WCPFC Convention Area, and
- CCMs shall require their fishing vessels to promptly release alive and unharmed, to the extent practicable, mobula rays as soon as possible.

Given the low mortality of the UoA relative to other sources of mortality, the representativeness of observer data based on observer coverage rates approaching 100%, the release of all mobula alive, the broad distribution of mobula species throughout the Pacific Ocean, the prohibition on retaining mobula, interactions with UoA vessels are likely to not hinder recovery of Giant Manta Rays and unidentified Mobula and Mantas , (devil rays); Given the near 100% observer coverage of UoA fishing operations, release of all mobula, annual reporting requirements. for mobula interactions to WCPFC, and implementation of recommended safe handling and release protocols (Poison et al., 2012), SG 60 is met. CMM 2019-05 established new reporting requirements for mobula interactions and comprehensive handling and release protocols, all of which entered into force in January 2021. Information is not available to determine if all UoA vessels are following the newly established measures (e.g., release any rays caught in purse seine fishing gear while they are still swimming freely). Additionally, there is the potential for an unobserved level of mortality, albeit minor, due to entanglement of smaller mobula in FADs. This potential threat is somewhat mitigated as all vessels operating in the WCPO are deploying the low-entanglement FADs specified under CMM 2018-01. However, we do not have information on the entanglement rate and on this basis SG 80 and SG 100 are not met.

Sei Whales

The sei whale inhabits most oceans and adjoining seas and prefers deep offshore waters (Gambell 1985). It avoids polar and tropical waters and semi-enclosed bodies of water. The sei whale migrates annually from cool, subpolar waters in summer to temperate, subtropical waters in winter with a lifespan of 70 years (Reeves et al., 1998). Information on the status of cetaceans in the WCPO is limited and much of the information is available through the IWC (https://iwc.int/status). The current abundance estimate for sei whales in the North Pacific Ocean is at 35,000 animals. In the Southern Hemisphere there are no recent accepted estimates of abundance or trends (https://iwc.int/estimate). Nonetheless the fishery undoubtedly comprises a negligible impact on these species. As no population estimate for the South Pacific Ocean at available, the overall impact of the fishery to the entire Pacific Ocean population would be lower. Considering the low level of sei whale interactions in the fishery, and that there are measures in place to minimise the risk posed by these fisheries, including safe handling and release protocols (CMM 2011-03), there is a high degree of confidence that the fishery is highly likely to not hinder recovery of Sei Whale populations in the WCPO. On this basis SG 60 and SG 80 are met.

A recent compilation of available information on cetacean interactions in WCPFC purse fisheries noted that between 2015 and 2019 purse seine fisheries in the WCPFC Convention Area interacted with 265 Sei Whales (Williams et al., 2020). This represents a very small portion of the total number of interactions by purse seine fisheries in the WCPO. Noting there is very low risk to Sei Whales from unobserved direct mortality, through ghost fishing or entanglement in FADs, the very small number of interactions provides a high degree of confidence that there are no significant detrimental direct effects of the UoA on this ETP species and SG100 is met.

Spinner Dolphin
Spinner Dolphins occur throughout tropical and subtropical waters in both hemispheres from approximately 40°N to 40°S. They inhabit the Pacific, Atlantic, and Indian Oceans, including the Persian Gulf and the Red Sea, and is the most common small cetacean in tropical pelagic waters (Perrin 2018). There is no global abundance estimate for this widely distributed species and available abundance estimates add up to more than a million dolphins. However, the vast majority of the species range remains unsurveyed, therefore the actual abundance is presumed to be considerably greater. There were an estimated 801,000 (coefficient of variation (CV)=37%) white-bellied spinner dolphins (S. l. orientalis – S. l. longirostris intergrades) in the ETP in 2000 (Gerrodette et al. 2005) and in the ETP the population of eastern spinner dolphins was estimated at 613,000 (CV=22%) in 2003 (Gerrodette and Forcada 2005). Despite large reductions in bycatch mortality since the 1970s, this population appeared to be recovering at an estimated rate of only 1.1% per year during the early 2000s. Spinner dolphin interactions with fishing activities in the WCPO was limited to FAD sets and a total 6 animals were caught. Assuming a population size of 613,000 animals for the Pacific Ocean, the USPTG undoubtedly comprises a negligible impact on this species, accounting for approximately 0.001% of the assumed Pacific Ocean population. Note the overall impact of the fishery to the entire Pacific Ocean population would likely be lower if population estimates of spinner dolphin were available for the WCPO and South Pacific Ocean. Considering the low level of Spinner Dolphin interactions in the fishery (approximately 1 interaction per year), and that there are measures in place to minimize the risk posed by these fisheries, including safe handling and release protocols (CMM 2011-03), there is a high degree of confidence that the fishery is highly likely to not hinder recovery of Spinner Dolphin populations in the WCPO. On this basis SG 60 and SG 80 are met.

A recent compilation of available information on cetacean interactions in WCPFC purse fisheries noted that between 2015 and 2019 purse seine fisheries in the WCPFC Convention Area interacted with 448 Spinner Dolphins, and the USPFG accounted for approximately < 1% of the interactions (Williams et al., 2020). This represents a very small portion of the total number of interactions by purse seine fisheries in the WCPO. However, there is a risk to Spinner Dolphins from unobserved direct mortality, through ghost fishing or entanglement in FADs. Potential threats from ghost fishing and entanglement are being mitigated as all vessels operating in the WCPO are deploying the low-entanglement FADs as specified under CMM 2018-01. However, we do not have information on the entanglement rate or success of the low-risk FADs and therefore it is not possible to confirm with a high degree of confidence that this potential unobserved mortality does not pose a significant risk to Spinner Dolphin populations. On this basis SG 100 is not met.

False Killer Whales
False Killer Whales are found in tropical to warm temperate zones, generally in relatively deep, offshore waters in all three major oceans and densities are much higher in tropical regions. In the ETP population abundance was estimated at 38,900 (coefficient of variation (CV) 0.64) based online-transect surveys from 1986-1991 (Wade and Gerrodette 1993). In the western North Pacific abundance was estimated at 16,668 (CV 0.26) based online transect surveys from 1983-1991 (Miyashita 1993). There is serious concern, about the false killer whale population around the main Hawaiian Islands, which was thought to number between 150 and 200 individuals in 2012, demonstrating a decline since 1989. As such, this population is designated as Endangered under the US Endangered Species Act. False Killer Whale interactions with fishing activities in the WCPO was. Assuming a population size of 16,668 animals for the WCPO, the fishery undoubtedly comprises a negligible impact on this species. Note the overall impact of the fleet to the entire Pacific Ocean population would likely be lower if population estimates of False Killer Whales were available for the wester South Pacific Ocean. Considering the low level of False Killer Whale interactions in the fishery (approximately 1 interaction every 2 years), and that there are measures in place to minimise the risk posed

by these fisheries, including safe handling and release protocols (CMM 2011-03), there is a high degree of confidence that the fishery is highly likely to not hinder recovery of False Killer Whale populations in the WCPO. On this basis SG 60 and SG 80 are met. A recent compilation of available information on cetacean interactions in WCPFC purse fisheries noted that between 2015 and 2019 purse seine fisheries in the WCPFC Convention Area interacted with 4226 False Killer Whales (Williams et al., 2020). This represents a very small portion of the total number of interactions by purse seine fisheries in the WCPO. Noting there is very low risk to False Killer Whales from unobserved direct mortality, through ghost fishing or entanglement in FADs, the very small number of interactions provides a high degree of confidence that there are no significant detrimental direct effects of the UoA on this ETP species and SG100 is met.

Scalloped Hammerhead
The Scalloped Hammerhead Shark is a coastal and semi-oceanic pelagic shark, found over continental and insular shelves and nearby deep water, ranging from the intertidal and surface waters to 275 m depth, though has been recorded to 1,043 m (Moore and Gates 2015). Adults spend most of the time offshore in midwater and females migrate to the coastal areas to pup (Stevens and Lyle 1989). Two distinct population have been identified in the Pacific Ocean, the Eastern Pacific DPS and the Indo-West Pacific DPS, and there are no data available on population size. in 2019 the IUCN listed the species as critically endangered. Based on observer data from 2015-201. Considering the extremely low level of interaction with Scalloped Hammerhead Sharks (1 animal in 5 years) and measures are in place to minimize the risk posed by these fisheries if needed, including safe handling and release protocols (CMM 2019-04), there is a high degree of confidence that the fishery is highly likely to not hinder recovery of Scalloped Hammerhead Shark populations in the WCPO. On this basis SG 60 and SG 80 are met.

There is a potential risk to Scalloped Hammerhead Sharks from unobserved direct mortality, through ghost fishing or entanglement in FADs. Potential threats from ghost fishing and entanglement are being mitigated as all vessels operating in the WCPO are deploying the low entanglement FADs as specified under CMM 2018-01. While the extent of their use is presently unknown given the observed low catch by the UoA, the very low number of observed interactions and an observer coverage rate approaching 100%, we can conclude that the potential for there to be significant levels of unobserved mortality through ghost fishing and entanglement comprises a negligible impact on this species; SG100 is met. It should be noted that after a review of the threats and needs of the Indo-West Pacific DPS, the US has decided not to propose protective regulations for this threatened DPS (https://www.federalregister.gov/documents/2014/07/03/2014-15710/endangered-and-threatened-wildlifeand-plants-threatened-and-endangered-status-for-distinct).

Therefore, all species meet at least SG60(b).

Indirect trophic effects of fishing for tuna on the tropical pelagic ecosystem have been considered through a variety of modelling approaches (Kitchell et al. 1999; Sibert et al. 2006; Allain et al. 2007; Allain et al. 2015; Lehodey et al. 2014) and, although the impacts are not negligible, they have not been considered irreversible and no particular impacts on ETP species have been identified. The effect of fishing on the WCPO warm pool ecosystem and species at different trophic levels has been investigated through extensive modelling (e.g., Allain et al. 2007; Allain et al. 2015; Lehodey et al. 2014). The results indicate that although the UoA tuna fisheries will impact the relative biomass of species at different trophic levels through indirect mechanisms (e.g., increasing the catch of smaller tuna decreases the biomass available to sharks and other apex predators but increase the biomass of other prey and smaller predatory species – Allain et al. 2015), the structure of the warm pool ecosystem is resistant to considerable perturbation (e.g. large changes in the harvest of the surface fish community). The intrinsic resistance of the ecosystem to perturbation (e.g., large changes in the harvest of the surface fish community) appears to be related to the high diversity of predators in the food web that consume a wide range of prey (Allain et al. 2015). The indirect effects have thus been considered for the UoA and are thought to be highly likely to not create unacceptable impacts; SG(c)80 is met. Recent data on the Indo-Pacific Warm Pool suggests it is expanding and the impact of this (expansion) on marine resources is unknown (https://www.climate.gov/news-features/featured-images/warm-pool-indopacific-ocean-has-almost-doubled-sizechanging-Global). The WCPFC has agreed to revisit the earlier modelling work of Allain;et al (2015) but it's unclear when results will be available. On this basis, until updated modelling results are available the assessment team concluded there is not a high

degree of confidence that there are no significant detrimental indirect effects of the UoA on ETP species SG(c)100 is not met.		
2.3.2 – ETP Management	**60 – 79**	**No**
Rationale or key points		
No update		
2.3.3 – ETP Information	**60 – 79**	**No**
Rationale or key points		
No update		
2.5.1 – Ecosystems Outcome	**≥80**	**No**
Rationale or key points		
The MSC defines 'key ecosystem elements' as "the features of an ecosystem considered as being most crucial to giving the ecosystem its characteristic nature and dynamics and are considered relative to the scale and intensity of the UoA. They are features most crucial to maintaining the integrity of its structure and functions and the key determinants of the ecosystem resilience and productivity" (SA3.16.3). Further MSC guidance states that "key ecosystem elements may include trophic structure and function (in particular key prey, predators, and competitors), community composition, productivity pattern (e.g., upwelling or spring bloom, abyssal, etc.), and characteristics of biodiversity" (GSA3.18.1). The UoA fishery occurs primarily in the equatorial region of the WCPO in the warm pool-cold tongue oceanographic feature (see section 7.3.1.12). The interface (convergence zone) between the of the warm pool and cold tongue is found in the WCPO, while the cold tongue extends throughout the EPO. Allain et al. (2007) describe the warm pool as an oligotrophic system characterized by low salinity, low nitrates, high temperature, deep thermocline, low surface chlorophyll and maximum chlorophyll located at 90m depth. The trophic structure of the warm pool-cold tongue ecosystem has been characterised using Ecopath and Ecosim models based on diet data (Allain et al. 2007). Skipjack tuna occupied a central position in the system as a key predator and prey species, with high biomass, high production, and high consumption and cannibalism. Juvenile skipjack tuna was a major source of food for all the top predators. The trophic structure of the cold tongue ecosystem has also been characterized using Ecopath and Ecosim models first by Olson and Watters (2003) and more recently updated by Griffiths et al (2021) using new time series of catch data to calculate updated values for a range of ecological indicators as a means of assessing the historic and recent (2018) status of the ecosystem. For this assessment, the ecosystem in the WCPO is defined as the warm pool – cold tongue pelagic ecosystem. The key ecosystem elements are then defined as 1) the WCPO warm pool – cold tongue oceanographic convergence zone, and 2) skipjack tuna as a key predator and prey species within the warm pool food web. The ocean environment changes on a variety of time scales, from seasonal to inter-annual, decadal, and longer. The dominant source of variability in the upper layers of the WCPO is the El Niño-Southern Oscillation (ENSO), an irregular fluctuation involving the entire tropical Pacific Ocean and the world's atmosphere (Fiedler 2002). El Niño events occur at two- to seven-year intervals, and are characterized by weaker trade winds, deeper thermoclines, and higher sea-surface temperatures (SSTs) in the equatorial EPO. El Niño's opposite phase, commonly called La Niña, is characterized by stronger trade winds, shallower thermoclines, and lower SSTs. The changes in the biogeochemical environment caused by ENSO have an impact on the biological productivity, feeding, and reproduction of fishes, seabirds, and marine mammals (Fiedler 2002), as well as the availability of commercially important tunas for capture. Noting that the warm pool-cold tongue pelagic ecosystem comprises a large oceanographic feature, the UoA fishery would not		

disrupt the physical factors driving ecosystem productivity in the WCPO warm pool. For these elements, requirements at the SG 60, SG(a)80, and SG(a)100 levels are met.

WCPO - Skipjack tuna as a key predator and prey species within the warm pool food web
Noting that estimates of spawning biomass for skipjack tuna in the WCPO are well above the level that will support MSY, and current fishing mortality is approximately half the MSY level the stock is not overfished or considered to be experiencing overfishing. Modelling of the trophic dynamics in the warm pool-cold tongue convergence zone noted that skipjack tuna appears to be a very resilient species, and nearly impossible to eliminate it from the system due to fishing. Griffiths et al. (2019) most recently used the ecosystem model of the western Pacific Warm Pool Province to explore the potential ecological impacts of varying FAD fishing effort (±50%) over 30 years. Their results indicated that reduction of FAD effort by at least 50% was predicted to increase the biomass of tuna species and sharks and return the ecosystem structure to a pre-industrial-fishing state within 10 years. The intrinsic resistance of the ecosystem to perturbation is likely related to the high diversity of predators in the warm pool-cold tongue food web that consume a wide range of prey (Allain et al 2015). Thus, resiliency of the ecosystem has not been impacted, and biological diversity would return to pre-fishing conditions. As per SA3.16.2, this study fulfils evidence required to determine that the UoA is highly unlikely to disrupt key elements underlying ecosystem structure and function to a point where there would be serious or irreversible harm, thus meeting the SG(a)80 for the WCPO. As there is no evidence that the UoA is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm, SG(a)100 is not met in the WCPO.

2.5.2 – Ecosystems Management	**≥80**	**No**

Rationale or key points

Noting that the warm pool-cold tongue pelagic ecosystem comprises a large oceanographic feature, the fishery would not impact the physical factors driving ecosystem productivity in the WCPO warm pool – cold tongue oceanographic convergence ecosystem. On this basis a partial strategy to mitigate impacts of the UoA are not necessary, and SG60 and SG80 are met. To meet SG100 requires a strategy, which consists of a plan, be in place, and that is not the case; SG(a)100 is not met.

WCPO - Skipjack tuna as a key predator and prey species within the warm pool food web
At the regional level, the 1995 FAO Code of Conduct for Responsible Fisheries is used as the framework for sustainable fisheries for an “Ecosystem Approach to Fisheries Management (EAFM)”. Tuna are important predatory species in the Pacific Ocean. The WCPFC’s application of the FAO code extends to the highly migratory fish species including tuna through Conservation and Management Measures such as CMM 2018-01 on the management of bigeye, yellowfin and skipjack, as well as to the management of non-target species, in particular through Resolution 2005-03 on Non-Target Fish Species and CMMs to improve the protection of sharks. The aim of CMM 2018-01 in relation to skipjack is to maintain spawning biomass on average at a level consistent with the interim target reference point of 50% of the spawning biomass in the absence of fishing. CMM 2018-01 also lays out catch controls, measures for FAD set managements, and capacity limitation measures. Tools adopted by WCPFC include effort limits in major purse seine fisheries, FAD closures, high seas closures, and a discard ban in purse seine fisheries. Explicit LRPs have also been adopted for biomass and the fishing mortality rate, together with an explicit MSY-related interim TRP. Although not specifically designed to manage impacts on the ecosystem, the range of measures in place are considered which take into account the potential impacts of the UoA on key elements of the ecosystem (the WCPO warm pool – cold tongue oceanographic convergence zone and skipjack tuna as a key predator and prey species within the warm pool foodweb) thus the SG60(a) is met. The measures in place are considered to be working cohesively, mainly through the monitoring, evaluation and implementation of fishing controls for main tuna species, the team considers these arrangements to be a partial strategy in place, which takes into account available information and is expected to restrain impacts of the UoA on the ecosystem, thus meeting the SG(a)80.

While there is monitoring of skipjack removals and regular determinations of stock status conducted, there is no harvest strategy in place for skipjack. We note that there is no specific ecosystem management plan for the WCPO but also SA3.17.3.2 states that 'It may not be necessary to have a specific "ecosystem strategy" other than that which comprises the individual strategies for the other component under P1 and P2.' There are measures in place to address the main impacts of the UoA as these would arise from the directed fishing at skipjack and yellowfin tuna. However, SA3.17.2 further states that the 'plan and measures in place at SG 100 should be based on well-understood functional relationships between the fishery and the components and elements of the ecosystem.' While ecosystem modelling activities in the WCPO have occurred, they are not based well-understood functional relationships. On this basis there is no strategy in place to address all main impacts of the UoA on the ecosystem and SG(a)100 is not met.

The fishery also engages in practices to minimise ecosystem impacts through the use of lesser entangling FADs as stipulated in Resolution C-19-01, as well as the mandatory conservation measures for sharks (C-11-10, C-19-05, C-19-06), rays (C-15-04), turtles (C-19-04), and non-target species (Resolution C-03-08), which includes using best handling and release protocols for released animals. Additionally, the FIP is engaged in Biodegradable FADs to further reduce the ecosystem impacts. Collectively these measures manage fishery impacts on trophic structure and function and are considered to constitute a partial strategy which takes into account available information and is expected to restrain impacts of the UoA on the ecosystem so as to achieve the Ecosystem Outcome 80 level of performance; SG60 and SG80 are met. Following the definition of a strategy outlined in Table SA8, the assessment team does not consider a strategy to be in place to specifically address ecosystem impacts and on this basis SG(a)100 is not met.

WCPO and EPO Pelagic ecosystem physical features
Noting that the warm pool-cold tongue pelagic ecosystem comprises a large oceanographic feature, the fishery would not impact the physical factors driving ecosystem productivity in the WCPO warm pool – cold tongue oceanographic convergence zone. On this basis a partial strategy to mitigate impacts of the fishery is not necessary, and SG(b)60 and SG(b)80 are met. To meet SG(b)100 requires.

WCPO - Skipjack tuna as a key predator and prey species within the warm pool food web
The regional stock assessments indicate that current harvest strategies and management measures have been successful in maintaining target species about the BMSY level. The strategy considers the significant sources of fishery related risks to the WCPO ecosystem, namely the removal of target species, risks associated with impacts of bycatch and discarding of a wide range of non-target ETP species. Overall, the strategy is considered likely to work. The extensive ecosystem modelling together with the current and projected future healthy status of skipjack tuna, a key predator and prey species, are results of a form of testing for the specific ecosystem that provides high confidence that the strategy will work. The measures are considered likely to work, based on plausible argument, mainly that the current harvest strategies and management measures have been successful in maintaining target species about the BMSY level, thus the SG(b)60 is met. The current status of main tuna stocks in the WCPO in addition with the existing fishing effort controls, provide information collected about the UoA, which in combination with expert knowledge (outputs of the ecosystem models described in PI 2.5.1) provide an objective basis for confidence, meeting the SG(b)80. Given the lack of systematic monitoring and research on ecosystem impacts, the SG(b)100 is not met.

WCPO and EPO Pelagic ecosystem physical features
Noting that the warm pool-cold tongue pelagic ecosystem comprises a large oceanographic feature, the fishery would not impact the physical factors driving ecosystem productivity in the WCPO warm pool – cold tongue oceanographic convergence zone. On this basis a partial strategy to mitigate impacts of the fishery is not necessary, and SG(c)80 is met. As there is no partial strategy in place SG(c)100 cannot be met.

WCPO - Skipjack tuna as a key predator and prey species within the warm pool food web
Stock assessments show that current management measures have largely been successful in maintaining target species well above PRI and at about the BMSY level. Available ecosystem modelling suggests it is unlikely the client fishery is having an impact on ecosystem functioning. The introduction of 100% observer coverage for the purse seine fisheries provides a platform for gathering information to monitor changes to

the ecosystem. All these activities constitute a partial strategy which meets requirements at the SG(c)80. Given that there is not a strategy in place with a clear objective the SG(c)100 is not met.		
2.5.3 – Ecosystems Information	**≥80**	**No**
Rationale or key points		
No update		

Table 2 - ETP Interactions Observed from Fishery Specific Catch Data

Common Name	Binomial Name	Justification	% of total (N)
Silky Shark	*Carcharhinus falciformis*	CMM 2013-08	0.038416
False Killer Whale	*Pseudorca crassidens*	CMM 2011-03	0.001206
Mantas, Devil Rays Nei	*Manta birostris*	CMM 2019-05 (In force January 2021)	0.001010
Bronze Whaler Shark	*Carcharhinus brachyurus*	Possibly landed in designated shark sanctuary (aggregated data from whole WCPO-precautionary ETP)	0.000663
Giant Manta	*Manta birostris*	CMM 2019-05 (In force January 2021)	0.000663
Blacktip Shark	*Carcharhinus limbatus*	Possibly landed in designated shark sanctuary (aggregated data from whole WCPO-precautionary ETP)	0.000587
Galapagos Shark	*Carcharhinus galapagensis*	Possibly landed in designated shark sanctuary (aggregated data from whole WCPO-precautionary ETP)	0.000455
Oceanic Whitetip Shark	*Carcharhinus longimanus*	CMM 2011-04	0.000404
Whale Shark	*Rhincodon typus*	CMM 2012-04	0.000309
Silvertip Shark	*Carcharhinus albimarginatus*	Possibly landed in designated shark sanctuary (aggregated data from whole WCPO-precautionary ETP)	0.000271
Sei Whale	*Balaenoptera borealis*	https://www.iucnredlist.org/ja/species/2475/130482064; CMM 2011-03	0.000246
Sandbar Shark	*Carcharhinus plumbeus*	https://www.iucnredlist.org/ja/species/3853/10130397; Possibly landed in designated shark sanctuary (aggregated data from whole WCPO-precautionary ETP)	0.000234
Short-Finned Pilot Whale	*Globicephala macrorhynchus*	CMM 2011-03	0.000215
Bryde's Whale	*Balaenoptera Edeni*	CMM 2011-03	0.000196
Pelagic Stingray	*Pteroplatytrygon violacea*	CMM 2019-05 (In force January 2021)	0.000152
Risso's Dolphin	*Grampus griseus*	CMM 2011-03	0.000139
Indo-Pacific Bottlenose Dolphin	*Tursiops aduncus*	CMM 2011-03	0.000051
Shortfin Mako Shark	*Isurus oxyrhinchus*	CMS Appendix II	0.000051
Bottlenose Dolphin	*Tursiops truncatus*	CMS Appendix II	0.000044
Green Turtle	*Chelonia mydas*	https://www.iucnredlist.org/species/4615/11037468; CMM 2018-04; CMS Appendix I; CITES Appendix I	0.000032
Pygmy Killer Whale	*Feresa attenuata*	CMM 2011-03	0.000032

Baleen Whales Nei	*Mysticeti*	CMM 2011-03	0.000013
Beaked Whales Nei	*Hyperoodontidae*	CMM 2011-03	0.000013
Grey Reef Shark	*Carcharhinus amblyrhynchos*	Possibly landed in designated shark sanctuary (aggregated data from whole WCPO-precautionary ETP)	0.000013
Loggerhead Turtle	*Caretta caretta*	https://www.iucnredlist.org/species/3897/119333622; CMM 2018-04; CMS Appendix I; CITES Appendix I	0.000013
Melon-Headed Whale	*Peponocephala electra*	CMM 2011-03	0.000013
Olive Ridley Turtle	*Lepidochelys olivacea*	https://www.iucnredlist.org/species/11534/3292503; CMM 2018-04; CMS Appendix I; CITES Appendix I	0.000013
Scalloped Hammerhead	*Sphyrna lewini*	CMS MoU species	0.000013
Black-Footed Albatross	*Phoebastria nigripes*	CMM 2018-03	0.000006
North Pacific Right Whale	*Eubalaena japonica*	https://www.iucnredlist.org/ja/species/41711/50380694; CMM 2011-03	0.000006
Hawksbill Turtle	*Eretmochelys imbricata*	https://www.iucnredlist.org/species/8005/12881238; CMM 2018-04; CMS Appendix I; CITES Appendix I	0.000006
Humpback Whale	*Megaptera novaeangliae*	CMM 2011-03	0.000006
Marine Turtle (Unidentified)	*Chelonioidea*	CMM 2018-04; CMS Appendix I; CITES Appendix I	0.000006
Pygmy Sperm Whale	*Kogia breviceps*	CMM 2011-03	0.000006
Spinner Dolphin	*Stenella longirostris*	CMS Appendix II	0.000006
Dusky Shark	*Carcharhinus obscurus*	CMS Appendix II	0.000000

References

Allain V., Griffiths S., Bell J. and Nicol S. 2015. Monitoring the pelagic ecosystem effects of different levels of fishing effort on the western Pacific Ocean warm pool. Issue-specific national report. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Nouméa, New Caledonia.

Allain V., Nicol S., Essington T., Okey T. Olson R.J. & Kirby D. 2007. An Ecopath with Ecosim model of the Western and Central Pacific Ocean warm pool pelagic ecosystem. Third regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission. 13-24 Aug. 2007. Honolulu, USA. WCPFC-SC3 – EB SWG/IP-8: 1-42.

Clarke, S., Yokawa, K., Matsunaga, H & Nakano, H. 2011. Analysis of North Pacific Shark Data from Japanese Commercial Longline and Research/Training Vessel Records. WCPFC-SC7-2011/EB-WP-02 (available at http://www.wcpfc.int/doc/eb-wp-02/analysis-north-pacific- shark-data-japanese- commercial-longline-and-researchtraining-ves)

Clarke, S., Manarangi-Trott, L., and Williams, P. 2015. Changes to Shark Reporting and Data Gaps Assessment Processes. WCPFC-SC11-2015/EB-WP-08.

Clarke S, A. Langley, C. Lennert-Cody. 2018. Pacific-wide Silky Shark (Carcharhinus falciformis) Stock Status Assessment. In: WCPFC Scientific Committee 14th Regular Session. WCPFC-SC14-2018/SAWP-08, Busan, Republic of Korea, p 137

Fernández-Álamo, M.A., and J. Färber-Lorda. 2006. Zooplankton and oceanography of the eastern tropical pacific: a review. Progress in Oceanography, V. 69, pp. 318-359.

Filmalter, J.D., Capello, M., Deneubourg, J.L., Cowley, P.D., Dagorn, L. (2013). Looking behind the curtain: quantifying massive shark mortality in fish aggregating devices. Frontiers in Ecology and the Environment 11: 291–296.

Gerrodette, T. and Forcada, J. 2005. Non-recovery of two spotted and spinner dolphin populations in the eastern tropical Pacific Ocean. Marine Ecology Progress Series 291: 1-21. Gerrodette, T., Watters, G. and Forcada, J. 2005. Preliminary estimates of 2003 dolphin abundance in the eastern tropical Pacific. SWFSC.

Griffiths S. and L. Fuller. 2019. An updated ecosystem model of the eastern tropical Pacific Ocean: analysis of ecological indicators and the potential impacts of FAD fishing on ecosystem dynamics. In: IATTC - 10th Meeting of the Scientific Advisory Committee. IATTC-SAC-10-15, San Diego, California

Kitchell, J.F., Boggs, C., He, X., Walters, C.J. 1999. Keystone predators in the Central North Pacific. Proceedings of the Wakefield Symposium on Ecosystem Considerations in Fisheries Management. University of Alaska Sea Grant. P 665–83 850 pp.

Lehodey P, Senina I, Murtugudde R (2008) A spatial ecosystem and populations dynamics model (SEAPODYM)—modelling of tuna and tuna-like populations. Prog Oceanogr 78:304–318

Lehodey, P. et al. 2011. Vulnerability of oceanic fisheries in the tropical Pacific to climate change. In: Bell J.D., Johnson J.E. and Hobday A.J. (Eds) Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change, Secretariat of the Pacific Community, 433-492

Lehodey, P., I. Senina, B. Calmettes, J. Hampton, S. Nicol. 2013. Modelling the impact of climate change on Pacific skipjack tuna population and fisheries. Climatic Change. Volume 119 (1), pp95-109.

Lennert-Cody, C.E., Aires-da-Silva, A., and M.N. Maunder. 2019. Updated stock status indicators for silky sharks (SAC-09-13). Report to the 10th Meeting of the IATTC Scientific Advisory Committee, San Diego, California, 13-17th May 2019.

Olson, Robert J., and Watters, George M. 2003. A model of the pelagic ecosystem in the eastern tropical Pacific Ocean. Inter-American Tropical Tuna Commission Bulletin, 22(3), pp. 135-218.

Rice, J., and S. Harley. 2013. Updated stock assessment of silky sharks in the western and central Pacific Ocean. Western and Central Pacific Fisheries Commission Scientific Committee WCPFC-SC2013/SA-WP-03.

Rice, J., S. Harley, N. Davies and J. Hampton. (2014) Stock assessment of skipjack tuna in the Western and Central Pacific Ocean. WCPFC-SC10-2014/SA-WP-05 Rev1.

Román, M.H., Aires-da-Silva, A. & N.W. Vogel. 2018. Whale shark interactions with the tuna-purse-seine fishery in the Eastern Pacific Ocean: summary and analysis of available data. Document BYC-08 INF-A. Inter-American Tropical Tuna Commission, Working Group on Bycatch, 8th meeting, La Jolla, 10-11 May 2018. 13 pp.

Sibert, J., Hampton, J., 2003. Mobility of tropical tunas and the implications for fisheries management. Mar. Policy 27, 87–95. https://doi.org/10.1016/S0308-597X(02)00057-X.

Tremblay-Boyer, S., McKechnie, S., Pilling, G., Hampton, J., 2017. Stock assessment of yellowfin tuna in the Western and Central Pacific Ocean. WCPFC-SC13-2017/SA-WP-06.

Tremblay-Boyer, L., Hampton, J., McKechnie, S. and Pilling, G. 2018. Stock assessment of south Pacific albacore tuna in the WCPO. WCPFC-SC14-2018/SA-WP-05.

Tremblay-Boyer, L., Carvalho, F., Neubauer, P., & Pilling, G. 2019. Stock assessment for oceanic whitetip shark in the Western and Central Pacific Ocean. WCPFC-SC15-2019/SA-WP-06.

Sibert, J.R., Hampton, J., Fournier, D.A., and Bills, P.J. (1999). An advection-diffusion-reaction model for the estimation of fish movement parameters from tagging data, with application to skipjack tuna (Katsuwonus pelamis). Can. J. Fish. Aquat.Sci. 56: 925-938.

Sibert, J., Hampton, J., Kleiber, P., and Maunder, M. 2006. Biomass, Size, and Trophic Status of Top Predators in the Pacific Ocean. Science. 314: 1773-1776.