Fisheries Operation Plan and impact assessment for Chub mackerel fishery within the NPFC Convention area

European Union

(Version of 27 January 2020)

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1 Purpose

The current paper sets out the application by the European Union (EU) for a Chub mackerel fishery in the Convention Area under the purview of the North Pacific Fisheries Commission (NPFC). Notably, the current paper develops the Fisheries Operation Plan, including area, target species, fishing method, quantity, data collection and a risk based assessment for the proposed fisheries to be undertaken in the North-western part of the NPFC Convention Area, in the high seas of FAO area 61. Please find below (in orange) the foreseen fishing area, which is for illustrative purposes only.

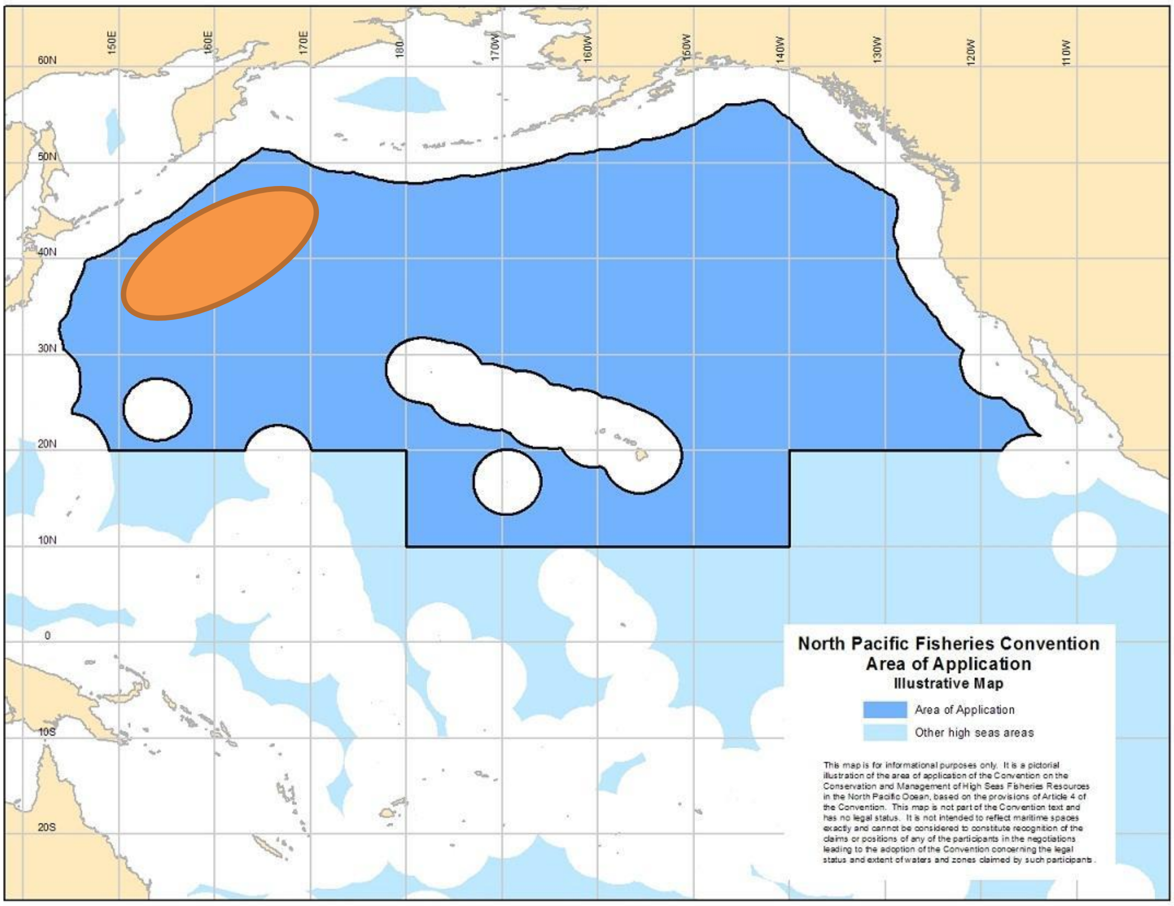

Figure 1.1: North Pacific Fisheries Convention Area of Application

2 Introduction

This document is a revised version of the Fisheries Operation Plan and Impact Assessment submitted by the EU to the North Pacific Fisheries Commission by letter dated 19 March 2019 in support of the EU's request to accede to the Convention on the Conservation and Management of the High Seas Fisheries Resources in the North Pacific Ocean. The Commission considered the EU's request (NPFC-2019-COM05-OP01) at its fifth annual session in Tokyo, Japan, from 16 to 18 July 2019.

Although the Commission was unable to reach consensus on the EU's request at that meeting, it noted in the final meeting report (NPFC-2019-COM05-Final Report) that the EU had provided all of the requested information and invited the EU to submit an application for accession to the Commission prior to its next annual meeting, along with information requested by some Members.

This document therefore sets out in more detail the EU's proposed plan to fish for Chub mackerel in the NPFC Convention area and accompanying impact assessment, in support of its application to be invited to accede to the Convention at the Commission's sixth annual session in 2020.

3 Fisheries Operation Plan

3.1 Description of the fishery

The objectives of the proposed Chub mackerel fishery are:

a) to explore the presence and distribution of Chub mackerel and other pelagic stocks in the NPFC Convention Area;
b) to collect and provide information and data on Chub mackerel and other pelagic stocks in specific, data-poor zones of the Convention Area, using a self-sampling programme (https://www.pelagicfish.eu/01320/);
c) to contribute to assessing the potential for developing a sustainably managed fishery on Chub mackerel and other pelagic stocks in the Convention Area;

The proposed fishery will be carried out according to this Fisheries Operation Plan and maintain strict compliance with applicable NPFC conservation and management measures, in particular CMM 2019-07 for Chub mackerel.

It is proposed to conduct the fishery by one EU pelagic freezer vessel (see section 3.2). The expected annual catch is estimated at around 20,000 tons of Chub mackerel. This proposed level is in agreement with the latest scientific estimates of the Chub mackerel stock and precautionary outtake levels and would thus not result in short to medium term (up to 5 years) adverse impacts on the stock (see section 4).

The proposed Chub mackerel fishery will take place in the NPFC convention area, outside the EEZs, in FAO area 61, as illustrated in Figure 1.1. Likely, the fishery will be restricted to the area west of 170°E, up to the border of the Convention area and north of 30°N. Moreover, within this area, the fishery will initially take place mainly east of 150°E, as indicated in figure 3.1 (red line).

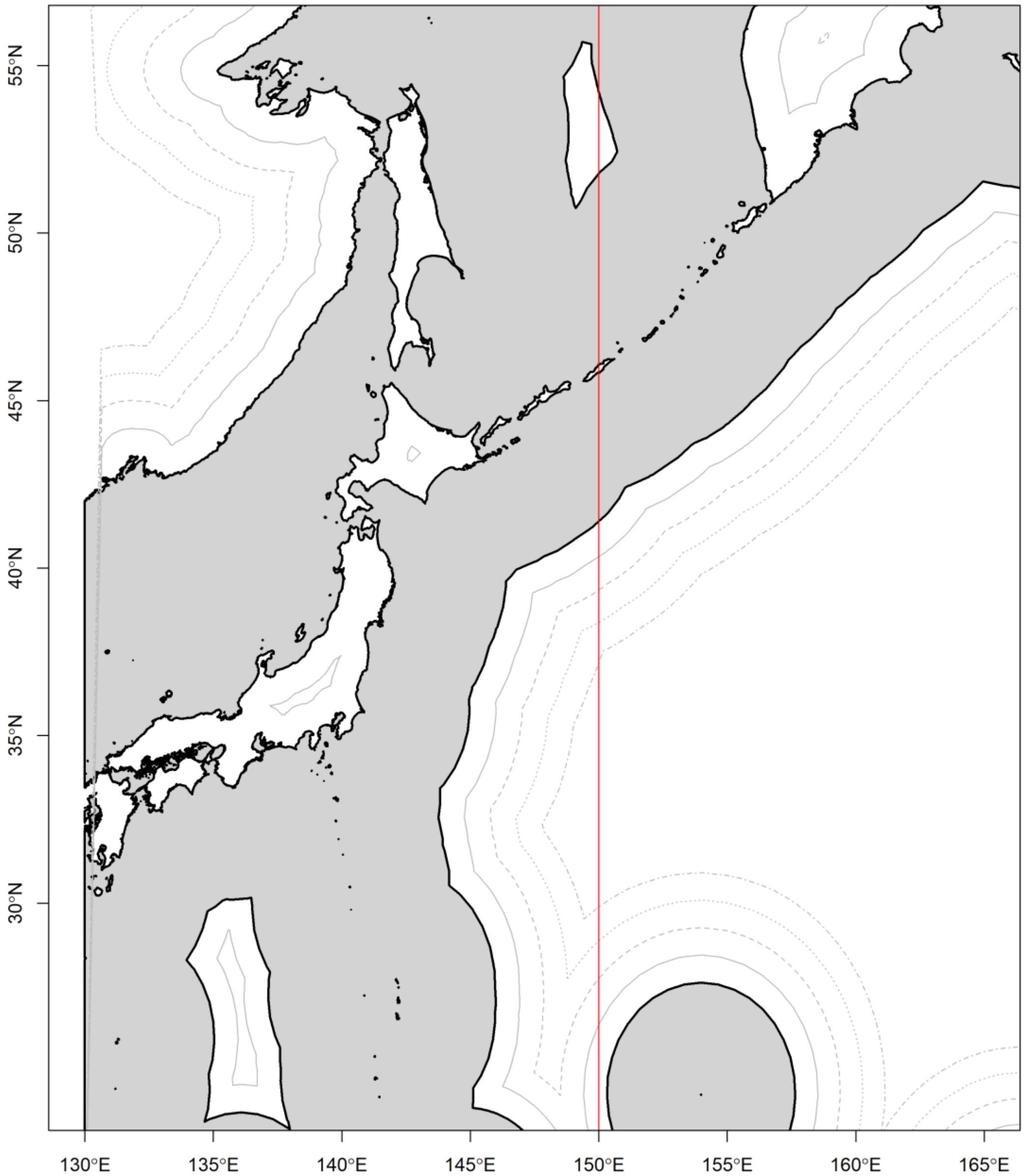

Figure 3.1: Map of Japanese Exclusive Economic Zone and adjacent countries (solid black line). The solid grey line represents 50 nm distance from the Japanese EEZ whereas the dashed, dotted and dash-dotted lines represent 100 nm, 150 nm and 200 nm distance respectively.

The expected destination of the catches is Africa (human consumption).

3.2 Vessel type and fishing gear

The EU pelagic industry uses freezer-trawlers for their pelagic fishing activities. About 80% of the capacity of a freezer-trawler is used for sorting, processing, freezing and cold-storage on-board, and the catch capacity is limited by the freezing capacity per 24 hours.

The proposed fishery will be conducted by one EU pelagic freezer-trawler with a capacity of 14,055 GT. Any replacement of this vessel, if necessary, would be carried out after informing the NPFC and, in the event of an increase in fishing capacity, subject to assessment by its Scientific Committee.

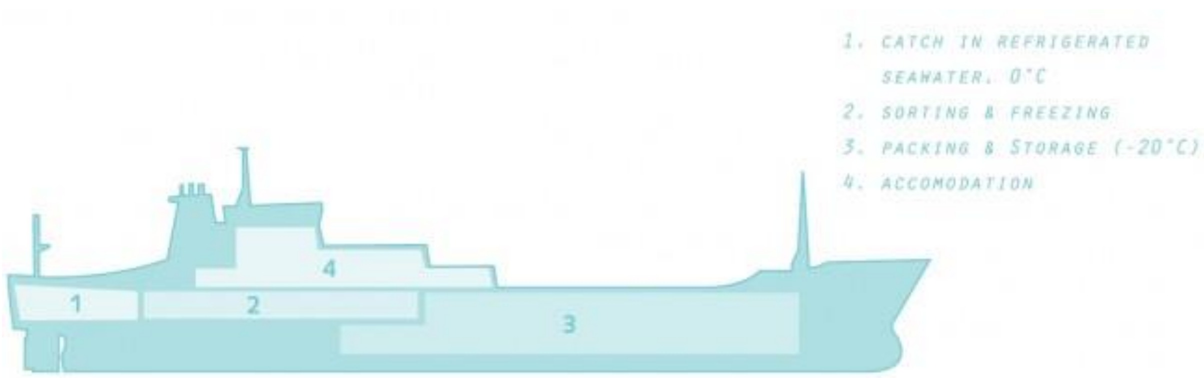

Figure 3.2. Schematic overview of a pelagic freezer trawler

The pelagic shoals are located with the help of fishing sonars and echo-sounding equipment. From the echogram it is possible to estimate the depth and the size of the shoal. The net, a so called midwater otter trawl (OTM), is towed behind the ship just below the water surface or further down the water column, but does not reach the sea bed. The expected fishing depth during the fishing will be the upper layer of the water column, until a depth of approximately 300 meters. The fishery is therefore not expected to have a bottom impact and hence a negligible impact on vulnerable marine ecosystem habitats or bottom species. A drawing of a midwater otter trawl is given in Figure 3.3, for illustration purposes only.

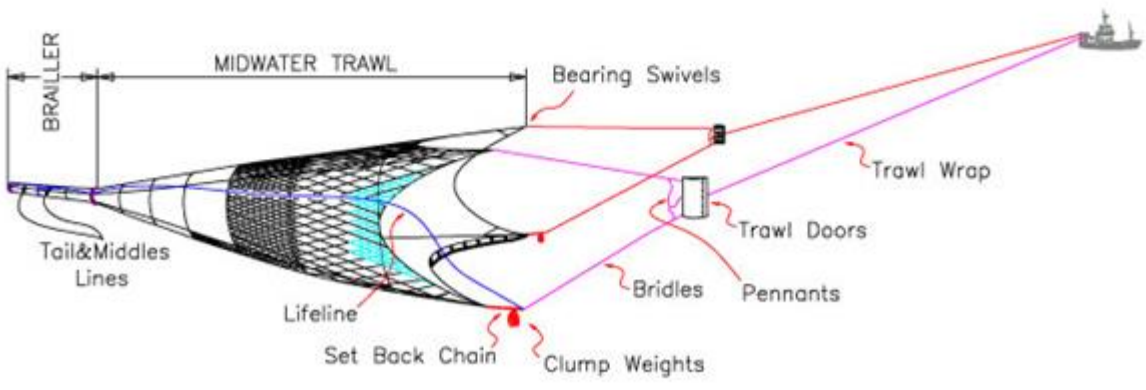

Figure 3.3. Schematic overview of the OTM gear used to fish for small pelagic fish such as Chub mackerel.

3.3 Time period of the fisheries operation plan

The fishery is foreseen to take place within the period from June until December on an annual basis. This period depends on the migration pattern of the Chub mackerel and is therefore subject to change due to variations in environmental conditions.

3.4 Biological information on the target species

3.4.1 Status of the stock

The Chub mackerel stock in the North-West Pacific has not officially been assessed by the NPFC yet. Individual assessments from Japan and Russia briefly reported in the annual report of the NPFC indicate that the stock biomass is at a recovery stage expanding towards the high seas from the Japanese Exclusive Economic Zone (EEZ), although it is lower than in the 1970's (North Pacific Fisheries Commission, 2018).

A stock assessment conducted by Japan in 2018 using a cohort analysis model, shows the spawning stock biomass (SSB - biomass of mature individuals) above the threshold where there is high risk of reduced recruitment (B_{lim} = 450 10^3 tons) for 2017 to be estimated at 906 10^3 tons. Fishing mortality (F) doubled in 2017 when compared with the previous year, however it is low when compared with the estimated F values of the entire time series. To account for the uncertainty in estimations attributed to the fluctuating reproductive rate and the exploitation of the stock from several countries, three catch scenarios were explored with different F's (a. maintaining the current F, i.e. $F_{current}$, b. maintaining the SSB at stable levels, i.e. F_{med} and c. allowing for an increase corresponding to 40% Spawning biomass Per Recruit (SPR), i.e. $F_{40\%SPR}$) in order to estimate the Allowable Biological Catch. Simulated forecasts quantifying the uncertainty show that in all three scenarios the probability of maintaining SSB above B_{lim} after 5 years is 100%. Furthermore, the trend in the last 5 years as seen in the stock assessment indicates that SSB is increasing (2013 to 2017), with a very strong recruitment year observed in 2013 and forecasted in 2018 (Yukami et al., 2018).

Information presented during the 2nd meeting of the Technical Working Group on the Chub Mackerel Stock Assessment suggests that the stock follows an increasing trend. Russian catches increased in 2018, reflecting an increase in effort and abundance. Chinese catches are increasing with a threefold increase in effort between 2014 and 2015. From 2016, there is a decrease in effort and in 2018 the catches are expected to increase by 10-20%.

Reported catch-at-age and biological information from Japan validate the 2013 strong recruitment year as the corresponding age classes are dominant in the catch of the subsequent years. In 2017, 4-year old individuals represented approximately half of the catch. Standardized recruitment indices indicate that in 2018 Catch per unit of effort doubled on average in comparison with 2013. Information on average weight and age shows delayed growth and maturity since 2014 which could be attributed to density dependence factor.

3.4.2 Historic catch records

Time series of catches from the stock assessment conducted by Japan can be been seen in figure 3.4. Historically, Chub mackerel has been fished by Japan and Russia in the North Western part of the Pacific Ocean. Russia halted fishing in the late 1980s and re-entered the fishery in recent years accounting for a small share of the catch. Reported catches from China indicate that the country started exploiting the stock in 2014, reaching approximately 190 10^3 tons in 2017 (derived from figure 3.4). The trend shows a historical high catch of Chub mackerel in 1977, declining to a historical low in 1991 and steadily increasing from 2013 until the end of the time series.

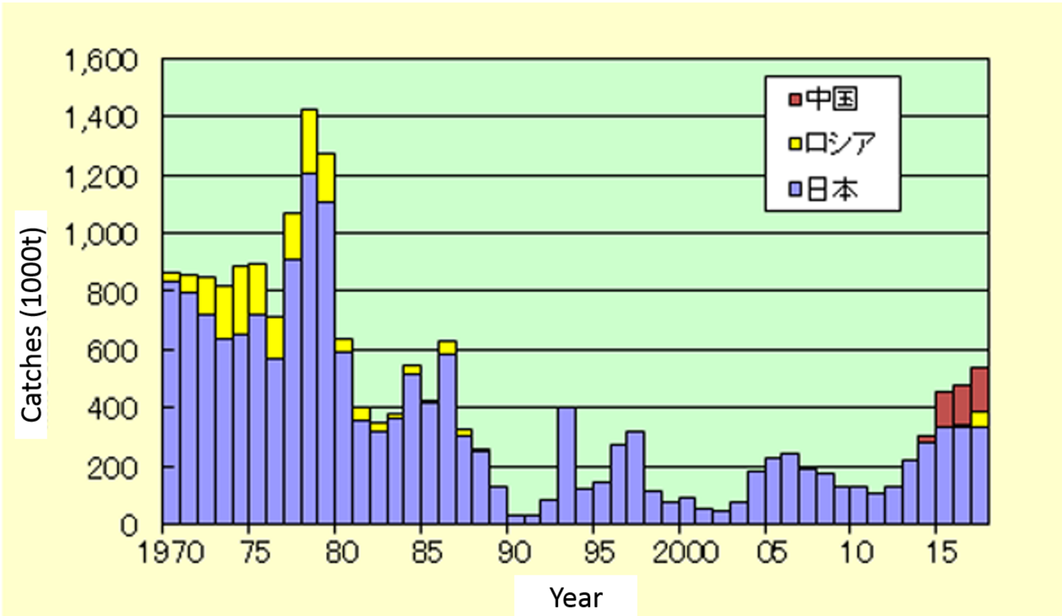

Figure 3.4: Time series of catch for the Pacific Chub mackerel stock as reported in the annual stock assessment of Japan. Blue, yellow and red represent Japanese, Russian and Chinese catches, respectively. Data source: (Yukami et al., 2018)

The combined catches for chub and spotted mackerel reported to the NPFC from the respective member countries in the North Western Pacific can be seen in figure 3.5. Chinese catches are reported to the NPFC from 2015 (NPFC-2018-AR-Annual Summary Footprint – Chub&Spotted mackerels), however the trend of the catches when compared with figure 3.4 is consistent.

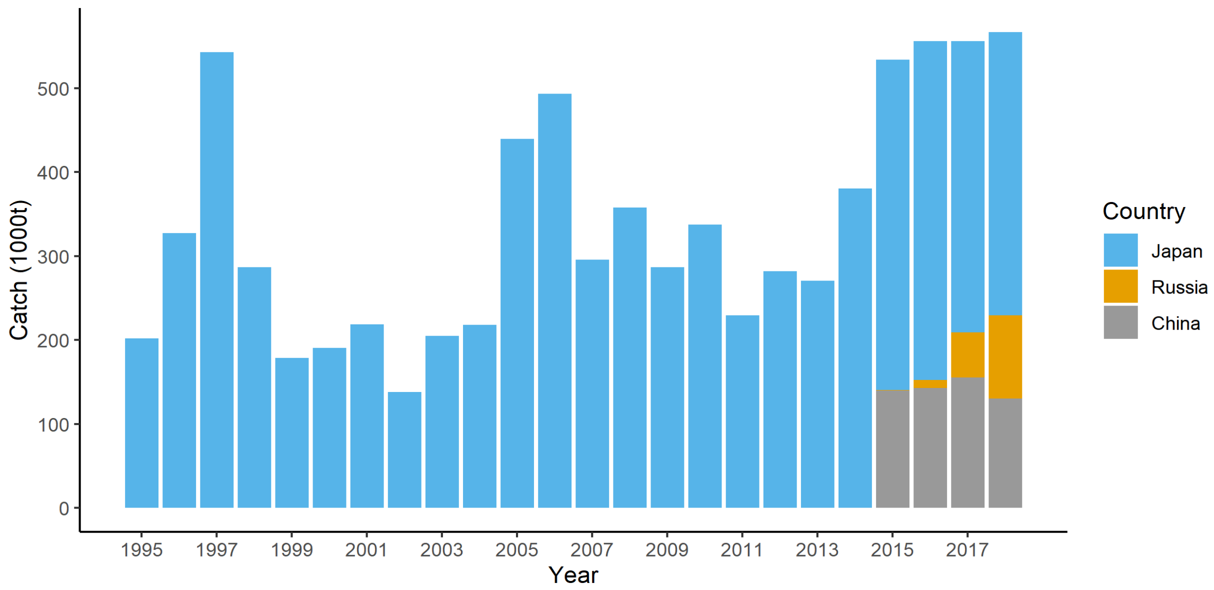

Figure 3.5: Catch time series for the spotted and Chub mackerel stocks combined as reported to the NPFC. Data source: (North Pacific Fisheries Commission, 2018)

3.4.3 Spatial distribution in relation to 200 mile zone

The spawning grounds of Chub mackerel are inside Japan's EEZ, with Izu islands considered as the main spawning area (Kamimura et al., 2015). Recruits enter the fishery which extends to the continental shelf, North East of the Hokkaido region in Japan (figure 3.6 dark grey shaded area/foraging area).

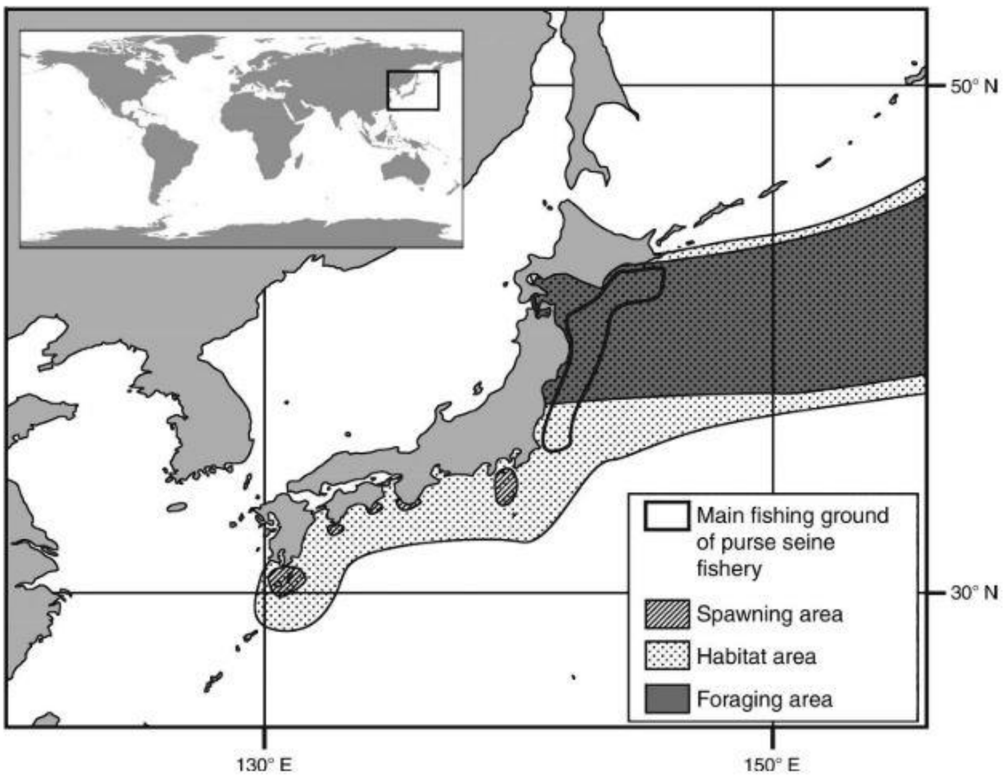

Figure 3.6: Spatial distribution of the North West Chub mackerel stock. Source: (Ichinokawa et al., 2015)

The nursery and feeding area of chub mackerel are located at the Kuroshio coastal area and the Kuroshio-Oyashio transition zone, respectively (figure 3.7). During high abundance periods the stock can expand to Oyashio and beyond 170°E while in low abundance periods it is restricted to the Kuroshio-Oyashio transition zone (Yatsu, 2019).

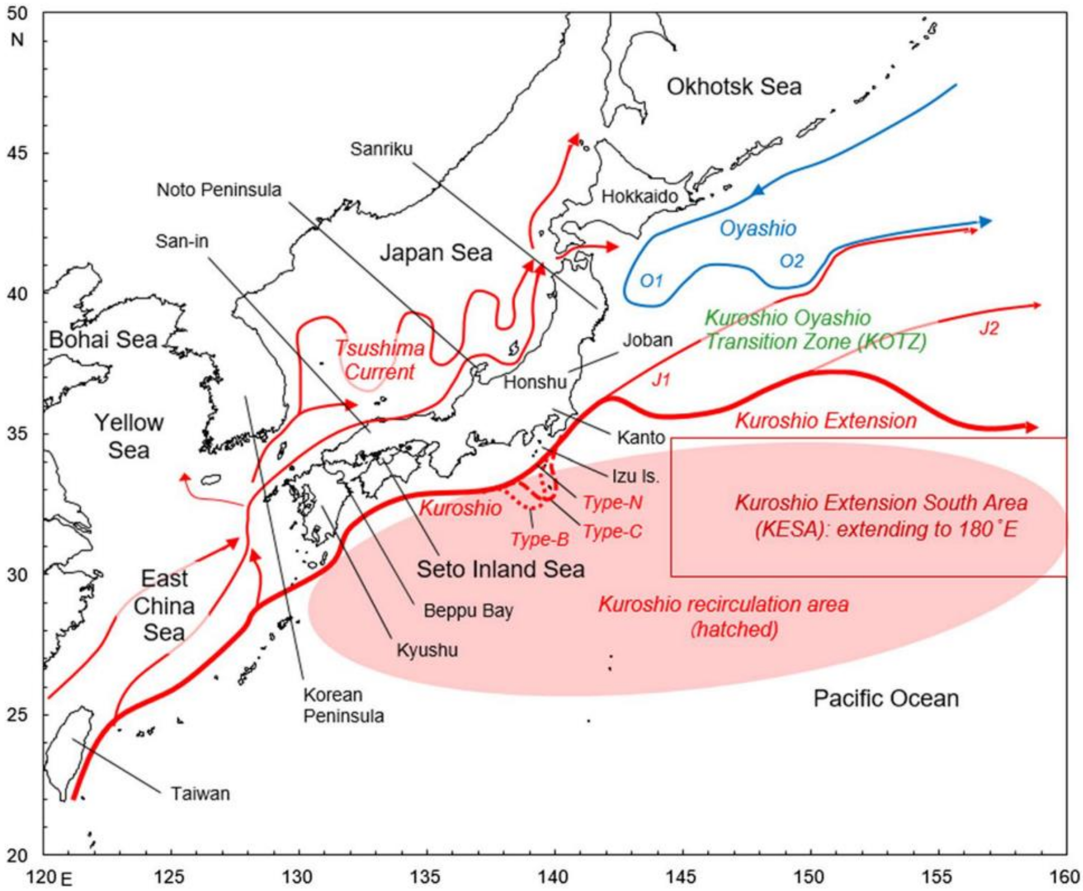

Figure 3.7: Important areas for small pelagic species around Japan. Source: (Yatsu, 2019)

3.4.4 Risk of the proposed fishery to the stock

A formal stock assessment for the chub mackerel stock in the North West Pacific is underway by the NPFC. From the information shared at the 1st and 2nd meetings of the Technical Working Group on Chub Mackerel Stock Assessment, as well as the results of the stock assessment conducted by Japan indicate an increasing trend in the stock and high productivity in especially 2013 and 2018. SSB is expected to remain well above B_{lim} under a range of tested fishing mortalities, including those in which catches increase to 1,049 10^3 tons. Under all scenarios evaluated, an increase in ABC larger than 20.000t is foreseen. We therefore conclude that the proposed catch under this fisheries operation plan is in agreement with the latest scientific estimates of the Chub mackerel stock and precautionary outtake levels and will thus not result in short to medium term (up to 5 years) adverse impacts on the stock.

3.5 Risk assessment

3.5.1 Non-target Fish

Consequences to populations
After evaluation of spatial overlap, catchability and mitigation, it is considered that the consequences to the non-target fish populations are low with a high likelihood of recovery over short time frames.

Summary Risk

Species category	Spatial overlap	Catchability	Risk of mortality
Secondary target spp	High	Japanese Spanish mackerel (*Scomberomorus niphonius*) alt. "Spotted mackerel" or "Japanese Seerfish", Japanese sardine (*Sardinops sagax melanostictus*) - High	High
Other main spp pelagic fishery (NPFC)	Medium	Blue mackerel, Flying squids, Pacific saury - Medium	Medium
Possible bycatch spp	Medium	Salmon spp, - Medium	Medium
	Low	Giant squid - Low	Low
Highly migratory fish spp, NW Pacific	Medium	Bullet mackerel , Pomfrets, Striped marlin, Shortbill spearfish, Swordfish - Medium	Medium
	Low	Yellowfin tuna, Bullet tuna, Blue marlin, Indo-Pacific sailfish - Medium	Low
	Mitigation		
	A precautionary by-catch limit is not considered necessary at this stage		
	Residual risk after mitigation		
	Low		

Background information for providing a risk assessment for reducing significant adverse impact (SAI) on non-target fish is presented in Appendix A, Table 01.

Mitigation
A by-catch limit on individual fish species will not be adopted for the survey.

3.5.2 Sharks, skates and rays

Consequences to populations
After evaluation of spatial overlap, catchability and mitigation, it is considered that the consequences to the populations of sharks, skates, and rays are low with a high likelihood of recovery over medium time frames.

Summary Risk

Spatial overlap	Catchability	Risk

Sharks - Medium	**Sharks- High**	**Sharks - Medium-High**
Skates and Rays - Low	**Skates and Rays - High**	**Skates and Rays - Medium**
Mitigation		
Precautionary by-catch limit		
Able to release at least some species alive		
Residual risk after mitigation		
Medium		

The geographical ranges of a number of oceanic and pelagic sharks, skates and rays potentially overlap with the designated fishing area. Many species of skates and rays are demersal and occur close to coasts, but a few species are pelagic. Pelagic shark species in general were considered to have Medium Spatial overlap as well as High Catchability in midwater trawls, resulting in a Medium-High Risk of mortality. Skates and Rays with a pelagic lifestyle were considered to have Low Spatial overlap as well as High Catchability in midwater trawls, resulting in a Medium Risk of mortality.

Mitigation

Sharks, skates and rays are unlikely to survive handling in pelagic trawl fisheries, but they shall be released in all cases where they are likely to survive.

All captured species of sharks, skates, and rays shall be photographed and identified.

3.5.3 Birds

Consequences to populations

After evaluation of spatial overlap, catchability, and mitigation to avoid or reduce risk of mortality, it is considered that the consequences to the seabird populations are low with a high likelihood of recovery over short time frames.

Summary Risk

Spatial overlap	**Catchability**	**Risk of mortality**
Albatrosses, Fulmars, Storm-petrels, Petrels, Shearwaters and Auklets - Medium	**kAlbatrosses, Fulmars, Storm-petrels, Petrels, Shearwaters and Auklets - Medium**	**Albatrosses, Fulmars, Storm-petrels, Petrels, Shearwaters and Auklets - Medium**
Skuas/Jaegers, Gulls, Boobys and Terns - Low	**Skuas/Jaegers, Gulls, Boobys and Terns - Medium**	**Skuas/Jaegers, Gulls, Boobys and Terns - Low**
Kittiwakes and Puffins - Medium	**Kittiwakes and Puffins - Low**	**Kittiwakes and Puffins - Low**
Murres and Guillemots - Low	**Murres and Guillemots - Low**	**Murres and Guillemots - Low**
Mitigation		
A) No-discharge policy, alternatively mincing and/or strategic discard management **B) Low aerial extent of cables** **C) Other mitigations, e.g., net binding, paired streamer lines, warp scarer, cable cones**		
Residual risk after mitigation (at least two mitigation measures, whereof A is one)		
Low		

Details on methods, data used, and analyses for providing a risk assessment for reducing significant adverse impact (SAI) is presented in Appendix A.

A total of 52 seabirds were identified as overlapping with the designated fishing area to varying degrees (Appendix A, Table 2). Some species are more attracted to fishing boats than others, and this may also vary depending on time of year or region. Seabirds may interact with pelagic trawlers by striking the warps towing the net, or cables, leading to injury or death, or being entangled as the net is close to surface when they try to obtain fish, mostly when the net is hauled. The risk to birds is greatly enhanced when offal from processing the catch aboard is being discarded. At-risk seabirds are therefore those that normally feed on the species targeted in the fishery, or species and sizes that may be discarded, or both.

It is important to note the uncertainty regarding the sensitivity of specific species. It is well known that the feeding behaviour and thus the species' sensitivity to risk from pelagic trawling varies within bird families, among populations as well as regions, and also depends on the time of year. Especially for a new fishery it will be essential to initially observe and monitor interactions between occurring bird species and the fishery. Recommended trigger levels should then be applied for decisions on mitigation measures, if needed.

Specific at-risk species

Albatrosses, Fulmars, Storm-petrels, Petrels, Shearwaters and Auklets are considered as being more at risk from pelagic trawling than other families of seabirds, as their spatial ranges and feeding behaviours imply that prey made available from trawling are attractive for their foraging. Among these, Short-tailed Albatross (*Phoebastria albatrus*), Leach's Storm-petrel (*Hydrobates leucorhous*), Tristram's Storm-petrel (*Hydrobates tristrami*), Stejneger's Petrel (*Pterodroma longirostris*), Cook's Petrel (*Pterodroma cookii*), White-necked Petrel (*Pterodroma cervicalis*), Buller's Shearwater (*Ardenna bulleri*), Flesh-footed Shearwater (*Ardenna carneipes*), Sooty Shearwater (*Ardenna grisea*), and Streaked Shearwater (*Calonectris leucomelas*) are either classified as Vulnerable or Near threatened (IUCN 2018). The Black-legged Kittiwake (*Rissa tridactyla*) is classified as Vulnerable (IUCN 2018), but in connection to trawling judged to be less at risk (Risk of mortality here classified to Low).

Mitigation

Relatively few studies have been conducted to study seabird interactions with trawlers (Lokkeborg 2011). The major conclusion which can be made is that a no-discharge policy, alternatively mincing offal prior to discharge, and/or consequent and strategic management of discharge, would be the most effective mitigation measures to avoid harm to seabirds in trawl fisheries. Therefore, a strategic discard management shall be applied (source: paragraph 21 of SPRFMO CMM 14b-2019):

- no dumping of offal while trawl is being set or hauled
- any offal or discards shall be minced prior to discarding
- discarding shall take place only when haul is finished or while steaming; and no biological material shall be discarded for at least 30 minutes before the start of setting or hauling the trawl.
- discarding will take place from the opposite side of the vessel from the hauling position.

Apart from discard practices, as birds may crash into warps and cables, reducing aerial exposure of warps and cables, streamer lines, or other measures taken to scare birds from cables have been proven effective (Lokkeborg 2011). Such mitigation measures shall therefore also apply.

Vessel Strikes

Light emission from vessel at night should be managed to avoid possible vessel-strikes of night-feeding birds.

Trigger / Action

A trigger level for bird-fishery interaction of 10 birds/100 hauls is suggested. If this limit is exceeded, evaluation of mitigation measures will be made, including that the mitigation measures are correctly applied, as well as strengthening mitigation where possible.

3.5.4 Marine mammals

Summary Risk

Spatial overlap	Catchability	Risk
Porpoises and Dolphins - High	**Porpoises and Dolphins - Medium**	**Porpoises and Dolphins - Medium**
Beaked whales, Sperm whales and Rorquals - High	**Beaked whales, Sperm whales and Rorquals - Low**	**Beaked whales, Sperm whales and Rorquals - Low**
Earless seals - High	**Earless seals - Low-Medium**	**Earless seals - Low-Medium**
Eared seals - Medium	**Eared seals - Low-Medium**	**Eared seals - Low-Medium**
Walruses - Medium	**Walruses - Low**	**Walruses - Low**
Mitigation		
A) Observation and monitoring programme (see e.g. CMM 14b-2018 [SPRFMO 2018]) **B) Avoidance of areas of visible mammal activity** **C) Seasonal avoidance of occurring species according to up-to-date information**		
Residual risk after mitigation (at least A and B)		
Low		

Details on methods, data used, and analyses for providing a risk assessment for reducing significant adverse impact (SAI) is presented in Appendix A.
A total of 40 species of marine mammals were identified as overlapping with the designated fishing area to varying degrees (Appendix A, Table 3). The majority of listed species of Porpoises, Dolphins, Beaked whales, Sperm whales, Rorquals as well as Earless seals are judged to have a high degree of potential overlap with the designated region for Chub mackerel fishery. Whales are likely to be at risk at or near the surface, the highest danger being susceptibility to collision when the whales may be rafting at the surface, e.g., after deep dives. Catchability of whales from midwater trawling itself is thought to be extremely low, and so is the risk of mortality.
Marine mammals having a risk of mortality from trawling classified as Medium are Porpoises and Dolphins. If these are swimming close to the fishing gear, it is easier for them to get entangled just as they are turning away from the net, as compared to seals which can more easily back off by swimming backwards.
Regarding marine mammals, as for seabirds, it is important to note the uncertainty regarding the sensitivity of specific species. Feeding strategies of marine mammals and their movements may vary among populations as well as regions, and also depend on the time of year. Especially for a fishery in a region

where relatively little is known concerning fishing interactions with marine mammals, it will be essential to observe and monitor these. Recommended trigger levels should then be applied for decisions on mitigation measures, if needed.

Specific at-risk species
Two of the species in the Dolphin family occurring in the area are listed by the IUCN (2018) as Data deficient, i.e., the Killer whale (*Orcinus orca*), and Near threatened, i.e., the False killer whale (*Pseudorca crassidens*).

Mitigation
Pre-setting and hauling assessments of mammal abundance in the vicinity will be done, and judgement will be made on a case-by-case basis as to whether vessel avoidance is necessary.

Trigger / Action
Any by-catch of marine mammals will trigger a re-evaluation of fishing strategy.

Consequences to populations
After evaluation of spatial overlap, catchability and mitigation, it is considered that the consequences to the mammal populations are low with a high likelihood of recovery over medium time frames.

3.5.5 Risk assessment on VME encounters

Consequences to populations
After evaluation of spatial overlap, catchability and mitigation, it is considered that the consequences to the VME populations are negligible.

Summary Risk

Spatial overlap	Catchability	Risk
VME species	VME species	VME species
VME habitats	VME habitats	VME habitats
Mitigation		
No spatial overlap - fishing depth is controlled by means of a netsounder (netsonde) or depth recorders Catchability is minimised using specific mesh sizes Limited impact footprint Midwater trawls have no contact with the seabed therefore there is negligible impact on habitats		
Residual risk after mitigation		
Negligible		

Details on methods, data used, and analyses for providing a risk assessment for reducing significant adverse impact (SAI) are presented in Appendix A.

There is no available data of VME grouping recorded and approved by NPFC. However, some indications of the VMEs, such as *Alcyonacea*, *Antipatharia*, *Gorgonacea* and *Scleractinia* were presented in Paragraph 83 of UNGA Resolution 61/105.

What is more, the IUCN Red List of Threatened Species classified the possible VME species from North Pacific as vulnerable (VU), endangered (EN) or critically endangered (CR). The identified species are as follows: 159 Cnidarias, 1 Mollusca and 6 of Echinodermata taxa on the Northwest Pacific; and 1 Mollusca, 1 Echinodermata taxa on the Northeast Pacific. All the above are classified as VU or EN species with decreasing population trend. *Pinto abalone* (Mollusca) is an exception and has stable population trend. Most of the analysed species can be found in the Neritic zone, relatively shallow waters, located above the drop-off of the continental shelf, approximately 200 meters in depth.

Mitigation
The potential impact of the midwater otter trawl (OTM) is low, especially with respect to VME habitat (SPRFMO, 2012; Ministry of Fisheries, 2008). The trawl fishing activity take place in the middle of the water column at a specified depth, above the bottom of the ocean or benthic zone. The fish shoals are positioned by sonar and the fishing depth level, which is controlled by the net sounder, is regulated by the length of the warps and/or the towing speed, thereby limiting dragging or the occurrence of entanglement.

Mesh size and configuration can highly increase selectivity of the species and its sizes. Managing the size or shape of the gear as well as the mode of deployment is therefore highly significant. The largest mesh sizes used so far are 128 mm. Further modern large midwater trawls may be made with mesh sizes above 400 mm in approximately three quarters of the length of the trawl. The effectiveness of mesh size as a mitigation tool for incidental catch management therefore needs to be evaluated accordingly on a fishery-specific basis.

In general, the gear of OTM does not touch the sea bottom, however there is a small probability of gear loss, and when it does occur, the benthic organisms may be impacted due to the weights of the gear. Improved fishing practices with more awareness of time, location, and configuration of gear when deployed may significantly limit the effect of the threat to the bottom VME species.

Consequences of populations
After evaluation of spatial overlap, catchability and mitigation, it is considered that the consequences to the VME populations are negligible.

4 Data Collection Plan

The current stock status of Chub mackerel is unknown. Several workshops are being held to set up a stock assessment for Chub mackerel. This means that specific requirements for data collection are unknown at the moment. Therefore the data collection as described below is preliminary and can be expanded with elements that the Scientific Committee might develop after establishing a stock assessment for Chub mackerel. In turn, the data collected as part of the proposed fishery will contribute to filling data gaps, in particular as regards data poor fisheries resource parts of the Convention area.

Prior to the start of the proposed fishing activities, the information described below is delivered to the NPFC:

1. A harvesting plan:
    a. Name of vessel
    b. Flag state of vessel
    c. Description of area to be fished (location and depth)
    d. Fishing dates
    e. Anticipated effort
    f. Target species and catch restriction to ensure that fisheries occur on a gradual basis in a limited geographical area.
    g. Fishing gear-type used
2. A mitigation plan
    a. Measures to prevent bycatch of bird, sharks, rays, etc.
3. A catch monitoring plan
    a. Recording/reporting of all species brought onboard to the lowest possible taxonomic level
    b. 100% satellite monitoring
    c. 100% self-sampling coverage
    d. Observer coverage in line with NPFC requirements
4. A data collection plan
    a. Data is to be collected in accordance with "Type and Format of Scientific Observer Data to be Collected"

The fishing vessel(s) involved in the proposed fishing operations will adhere to the requirements detailed in the CMMs of the NPFC that apply to this proposal.

Data about the fishing activity will be collected and shared through a self-sampling program (https://www.pelagicfish.eu/01320/) providing detailed insights in temporal and spatial patterns relevant for fisheries and for biological and ecological understanding of ecosystems where the fishing activities are undertaken.

The following main elements can be distinguished in the self-sampling protocol:
- haul information (date, time, position, weatherconditions, environmental conditions, gear attributed, estimated catch, optionally: species composition)
- batch information (total catch per batch=production unit, including variables like species, average size, average weight, fat content, gonads y/n and stomach fill)
- mechanisms for linking batch and haul information (essentially a key of how much of a batch is caught in which of the hauls. There can be multiple batches in a haul or multiple hauls in a batch)
- length information (length frequency measurements, either by batch or by haul)

5 Post-Survey Science Reporting

Within three months of the end of the fishing activities or within 12 months of the commencement of fishing, whichever occurs first, a report of the results of the fishing of Chub mackerel described in this proposal will be provided to the NPFC. The information to be included in the report is described below:
- Flag state of vessel

- Description of area fished (location and depth)
- Fishing dates
- Total effort
- Total catch
- Mitigation measures taken in response to the encounter of birds, skates, rays, VMEs etc.
- List of all organisms brought onboard

6 References

Arreguin-Sanchez, F. (1996). Catchability: a key parameter for fish stock assessment. Review in Fish Biology and Fisheries 6, 221-242.

Baer, A., Donaldson, A., and Carolsfeld, J. (2010). Impacts of Longline and Gillnet Fisheries on Aquatic Biodiversity and Vulnerable Marine Ecosystems. Canadian Science Advisory Secretariat. Res. Doc. 2010/012 vii + 78.

Canada Department of Fisheries and Oceans (2010). Potential impacts of fishing gears (excluding mobile bottom-contacting gears) on marine habitats and communities. Canadian Science Advisory Secretariat science advisory report 1919-50872010/003, National Capital Region, 24p. ISSN, 1919-5087.

Christensen, V and Pauly, D. (1992). ECOPATH II: a software for balancing steady-state ecosystem models and calculating network characteristics. EcoZ. ModelZing 61, 169-85.

Ichinokawa, M., Okamura, H., Watanabe, C., Kawabata, A., & Oozeki, Y. (2015). Effective time closures: Quantifying the conservation benefits of input control for the Pacific chub mackerel fishery. *Ecological Applications*, *25*(6), 1566–1584. https://doi.org/10.1890/14-1216.1

Kamimura, Y., Takahashi, M., Yamashita, N., Watanabe, C., & Kawabata, A. (2015). Larval and juvenile growth of chub mackerel Scomber japonicus in relation to recruitment in the western North Pacific. *Fisheries Science*, *81*(3), 505–513. https://doi.org/10.1007/s12562-015-0869-4

North Pacific Fisheries Commission. (2018). *Annual summary footprint for chub mackerel and spotted mackerel in the north pacific fisheries commission area of competence*.

Yatsu, A. (2019). Review of population dynamics and management of small pelagic fishes around the Japanese Archipelago. *Fisheries Science*, *85*(4), 611–639. https://doi.org/10.1007/s12562-019-01305-3

Yukami, R., Nishijima, S., Isu, S., Watanabe, C., Kamimura, Y., & Hashimoto, M. (2018). Stock assessment and evaluation for the Pacific stock of chub mackerel (fiscal year 2017/2018). *Marine Fisheries Stock Assessment and Evaluation for Japanese Waters (Fiscal Year 2017/2018). Fisheries Agency of Japan and Fisheries Research and Education Agency of Japan, Tokyo*, 157-200 (in Japanese).

SPRFMO. 2019. Conservation and Management Measure for Exploratory Potting Fishery in the SPRFMO Convention Area. CMM 14b-2019, South Pacific Regional Fisheries Management Organization. Available at https://www.sprfmo.int/measures/

SPRFMO (2012). Bottom Fishery Impact Assessment Standard. 31pp. http://www.southpacificrfmo.org/assets/Science/Benthic-Impact-Assessments/SPRFMO-Bottom-Fishing¬Impact-Assessment-Standardagreed-Vanuatu-Fri23Sep2011-1140am.pdf.

Appendix A: Risk assessment

Table 1. Likely occurring fish and squid species, targeted as well as non-targeted, included for risk analysis of exploratory fishing for Chub Mackerel within the NFCM Convention area, with background information concerning habitat, feeding, and breeding used for classification of spatial overlap, catchability, and risk of mortality.

Species category	**Species**	**IUCN**	**Spatial overlap**	**Catchability**	***Risk combined (Spatial overlap * Catchability)***	**Risk of mortality**	**Habitat**	**Feeding**	**Fishery**
Main targeted spp pelagic fishery (designated fishery)	Chub mackerel (Scomber japonicus)	LC	3	3	*9*	3	Found to depths of 300 m, stays near the bottom during day and goes up to the open water at night	Copepods and other crustaceans, fish and squid	Purse seines (often together with sardines) sometimes using light, also with trolling lines, gill nets, traps, beach seines, and midwater trawls
Secondary targeted species (designated fishery)	Japanese Spanish mackerel (Scomberomorus niphonius) alt. common names: "Spotted mackerel" or "Japanese Seerfish"	DD	3	3	*9*	3	Pelagic, oceanodromous, also found nearer to shore	Small fishes	Major fishing gear is set nets, most important mackerel species in Japan
Secondary targeted species (designated fishery)	Japanese sardine (Sardinops sagax melanostictus)	LC	3	3	*9*	3			
Other main targeted spp pelagic fishery (NPFC)	Blue mackerel (Scomber australasicus)	LC	2	2	*4*	2	Pelagic, schools by size (schools may include Jack Mackerels and Pacific sardines)	Copepods and other crustaceans, adults also feed on small fish and squids	Purse seines
Other main targeted spp pelagic fishery (NPFC)	Neon flying squid (Ommastrephes bartramii)	LC	2	2	*4*	2	Occur at depths of less than 40 m by night and depths of 150-300 m by day	Anchovies, crustaceans, gastropods and chaetognaths, as well as cephalopods including conspecifics	Heavily fished in the North Pacific, also via jigging
Other main targeted spp pelagic fishery (NPFC)	Japanese flying squid (Todarodes pacificus)	LC	2	2	*4*	2	Typically from 0 to 100 m depth (maximum500 m), highly migratory, large aggregations around oceanic fronts and seamounts		

Other main targeted spp pelagic fishery (NPFC)	Pacific saury (Cololabis saira)	n.a.	2	2	*4*	2	Highly migratory. Usually found near surface (although depth range of 0 – 230 m), known to glide above the surface of the water when moving away from predators. Prey of scombrids.	Zooplankton, such as copepods, krill, amphipods	Attracted to light (i.e., used for fishing)
Possible bycatch spp	Giant Squid (Architeuthis dux)	LC	1	1	*1*	1	Occurs at mesopelagic depths (200-900 m).	Crustaceans, fish and other cephalopods	Unlikely to be a target of commercial fisheries (high level of ammonium ions in tissue)
Possible bycatch spp	Pink salmon (Oncorhynchus gorbuscha)	n.a.	2	2	*4*	2	Ocean and coastal streams, epipelagic	Adults feed mainly on invertebrates, squid and small fishes	
Possible bycatch spp	Chum salmon (Oncorhynchus keta)	n.a.	2	2	*4*	2	Ocean and coastal streams, epipelagic	Adults feed mainly on invertebrates, squid and small fishes	Subject to fisheries in ocean and during spawning migration.
Possible bycatch spp	Sockeye Salmon (Oncorhynchus nerka)	LC	2	2	*4*	2	1-3 years offshore. Isolated spawning populations (in freshwater) with considerable genetic differentiation and adaptation to local conditions. Spawning in late summer-autumn.	Diet in the ocean consists primarily of zooplankton (copepods and euphausiids), but their diet also includes squids and fishes.	Subject to fisheries in ocean and during spawning migration.
Possible bycatch spp	Coho salmon (Oncorhynchus kisutch)	n.a.	2	2	*4*	2	Part of life cycle in offshore feeding areas. Considerable genetic differentiation and adaptation to local conditions in isolated spawning populations. Spawning occurs in late summer and autumn.		Subject to fisheries in ocean and during spawning migration.
Possible bycatch spp	Chinook salmon (Oncorhynchus tshawytscha)	n.a.	2	2	*4*	2	Spend part of life cycle in offshore feeding areas. Some make extensive migrations at sea. Adults return to natal streams from the sea to spawn.		Subject to fisheries in ocean and during spawning migration.

Possible bycatch spp	Masou salmon (Oncorhynchus masou)	n.a.	2	2	*4*	2	Found only in the western Pacific Ocean in Japan, Korea, and Russia	Feeds at sea on small fishes and pelagic crustaceans	Subject to fisheries in ocean and during spawning migration.
Highly migratory fish spp, western & central N Pacific	Yellowfin tuna (Thunnus albacores)	NT	1	2	*2*	1	Outside range? (more southern)		
Highly migratory fish spp, western & central N Pacific	Bullet tuna (Auxis rochei)	LC	1	2	*2*	1	Outside range? (more coastal and southern)		
Highly migratory fish spp, western & central N Pacific	Bullet mackerel (Auxis thazard)	LC	2	2	*4*	2	Oceanodromous species, epipelagic in neritic and oceanic waters, juveniles are more widely spread throughout the ocean	Feeds on small fish, squids, planktonic crustaceans (megalops), and stomatopod larvae	
Highly migratory fish spp, western & central N Pacific	Pacific pomfret (Brama japonica)	n.a.	2	2	*4*	2	Highly migratory, oceanic and epipelagic species, also found to 1000 m.	Feeds on crustaceans (amphipods and euphausiids), small fishes and squid	
Highly migratory fish spp, western & central N Pacific	Rough pomfret (Taractes asper)	n.a.	2	2	*4*	2	Offshore		
Highly migratory fish spp, western & central N Pacific	Shortbill spearfish (Tetrapturus angustirostris)	DD	2	2	*4*	2	Oceanic and epipelagic, found above the thermocline	Fish, cephalopods and crustaceans	Bycatch hook-and-line (tuna)
Highly migratory fish spp, western & central N Pacific	Striped Marlin (Tetrapturus audax)	NT	2	2	*4*	2	Usually above thermocline but found to depths of ~300 m. Abundance increases with distance from the continental shelf.	Wide variety of fishes, crustaceans, and squids	
Highly migratory fish spp, western & central N Pacific	Blue marlin (Makaira nigricans)	VU	1	2	*2*	1	Epipelagic and oceanic mostly confined waters warmer than 24°C, known to undergo seasonal north-south migrations. Found to 1,000 m depth but mostly above 40 m, not usually seen close to land.	Squids, tuna-like fishes, crustaceans, and cephalopods	

Highly migratory fish spp, western & central N Pacific	Indo-Pacific sailfish (Istiophorus platypterus)	NT	1	2	*2*	1	Oceanic and epipelagic species usually above thermocline. Most densely distributed close to coasts and islands. Spawning migrations in the Pacific.	Mainly fishes, crustaceans and cephalopods	
Highly migratory fish spp, western & central N Pacific	Swordfish (Xiphias gladius)	LC	2	2	*4*	2	Mainly oceanic generally above the thermocline, preferring temperatures of 18–22°C, migrates toward temperate or cold waters for feeding in the summer.	Uses sword to kill fishes, also on crustaceans and squids. Opportunistic foraging from surface to bottom, typically deep (>500 m) during the day and in the mixed layer at night.	

Method of classification of Spatial overlap, Catchability, and Risk of mortality for birds and marine mammals

Marine bird species (Table 2) and marine mammals (Table 2) with their ranges overlapping with the designated fishing area were listed. Information on geographical ranges was collected from various sources (see References). Information on Habitat, Feeding, and Breeding (period of year) was also collected in the table, as basis for classification of spatial overlap and catchability.

Spatial overlap was classified in three steps.

1. The geographical range was classified as "within geographical range" (2) or "border of geographical range, or uncertain" (1).

2. A mean spatial overlap score was calculated for each family. If the species within the family had a proportion of class 1 (border of geographical range, or uncertain) species greater than 30% (e.g., petrels, dolphins), the mean geographical range was adjusted to the average of the class 2 (within geographical range) species, as this was judged to be more relevant.

3. For birds, spatial overlap class 2 was set to Medium, and class 1 was set to Low. This was based on the fact that birds also occupy air and are not bound to the sea where the fishing gear is located. For mammals, spatial overlap class 2 was set to High and class 1 was set to Medium, based on the fact that marine mammals are bound to the sea.

Catchability was classified in three steps.

1. First, "primary catchability" was subjectively classified with respect to the relative sensitivity among the listed species, based on the collected information concerning their feeding, into classes High (3), Medium (2), or Low (1).

2. For the second step, consideration was taken to the fact that the gear-specific risk of midwater trawls to birds is considered as Medium (in comparison with, e.g., drift gillnets or pelagic longline which are considered to pose high risk for birds, or pots and traps which are considered to pose low risk for birds). For each species, the "primary catchability" categories 1-3 from the first step were secondly categorized into Medium (2) catchability, if the "primary catchability" was High, or Low (0, or 1) catchability if the "primary catchability" was Medium and Low. This was done by subtracting the "primary catchability" score with 1.

3. A mean catchability score was then calculated for each family.

For Earless seals and Eared seals the catchability was subjectively adjusted from Low to Low-Medium, based on literature examples of captures of seals in midwater trawl fisheries together with information on their feeding behaviour.

Risk of mortality was classified in two steps.

1. The mean spatial overlap score was multiplied with the mean catchability score for each family, to obtain a "primary risk" score (0-4).

2. The Risk of mortality was classified as either Medium based on "primary risk" scores 2-4, or Low based on "primary risk" scores below 2. The reason for limiting the Risk of mortality classes to Medium or Low was that the gear-specific risk of midwater trawls is considered as being Medium, and thus was the Risk of mortality not judged to be able to be High.

For Earless seals and Eared seals, the Risk of mortality was subjectively adjusted from Low to Low-Medium, based on the catchability classified as Low-Medium, as well as a High (Earless seals) or Medium (Eared seals) classified spatial overlap.

Table 1. Marine bird species included for risk analysis of exploratory fishing for Chub Mackerel within the NFCM Convention area, with background information concerning habitat, feeding, and breeding used for classification of spatial overlap, catchability, and risk of mortality.

Family	**Preliminary species list of seabirds (with IUCN classification)**	**ETP spp risk level_1_2_3**	**Spatial overlap_1_2**	***Catchability_1_2_3***	**Catchability_new**	**Risk_combined**	**Mean_est_risk_family**	**Mean_spatial_overlap_family**	**Mean_catchability_family**	**Risk**	**Habitat**	**Feeding**	**Breeding**
Albatrosses	Short-tailed Albatross (Phoebastria albatrus) – VU	2	2	*3*	2	4	3	2.0	2.7	2	Marine and pelagic, concentrations in areas of upwelling	Squid (probably at night), fish, crustaceans, galley refuse and offal (attracted to fishing vessels)	Starts October, fledglings May-June
Albatrosses	Black-footed Albatross (Phoebastria nigripes) – NT	2	2	*3*	2	4					Marine and pelagic, rarely approaches land	Day and night, eats mainly fish, flying fish eggs and fish offal, crustaceans, squid, galley refuse and offal (follows ships, also attends trawlers)	Starts November
Albatrosses	Laysan Albatross (Phoebastria immutabilis) – NT	2	2	*2*	1	2					Marine and pelagic, rarely approaches land	Squid (at night), fish, crustaceans, jellyfish (does not often follow ships)	Starts November
Fulmars	Northern Fulmar (Fulmarus glacialis) – LC	1	2	*3*	2	4	4	2.0	3.0	2	Marine, mostly over continental shelf	Day and night, eats fish, squid, zooplankton, fish offal, whale blubber (frequently attends trawlers where large numbers may gather)	Starts May
Storm-petrels	Leach's Storm-petrel (Hydrobates leucorhous) – VU	2	2	*2*	1	2	2	1.7	2.2	2	Marine and pelagic, often areas of upwelling or over continental shelf	Night and day, small fish, planktonic crustaceans, squid, offal, sometimes follows marine mammals	Starts May
Storm-petrels	Band-rumped Storm Petrel (Oceanodroma castro) – LC	2	2	*3*	2	4					Highly pelagic (warm waters?), rarely approaching land except near colonies.	Mostly on planktonic crustaceans, fish and squid but also on human refuse. Mainly feeds during day on the wing by pattering, dipping, also by surface-seizing.	Varies locally
Storm-petrels	Swinhoe's Storm Petrel (Oceanodroma monorhis) – NT	2	1	*2*	1	1					Marine species found over pelagic and inshore waters	Feeds mainly on the wing by dipping and does not patter.	Starts April
Storm-petrels	Tristram's Storm-petrel	2	2	*2*	1	2					Marine and pelagic, rarely approaching land	Small fish, squid, planktonic crustaceans	In local winter (December-January)

	(Hydrobates tristrami) – NT												
Storm-petrels	Matsudaira's Storm Petrel (Oceanodroma matsudairae) – VU	2	1	2	1	1					Marine and pelagic. In non-breeding season generally pelagic, occurring far from the coast.	n.a.	Begins January (fledglings in June)
Storm-petrels	Fork-tailed Storm Petrel (Oceanodroma furcata) – LC	2	2	2	1	2					Generally forages on continental shelves, closer to the shore whilst breeding.	Mainly planktonic crustaceans, small fish and squid, feeds on the wing or by surface-seizing	n.a.
Petrels	Stejneger's Petrel (Pterodroma longirostris) – VU	2	1	3	2	2	3	2.0	3.0	2	Marine and highly pelagic, trans-equatorial migrant	Squid, small fish	Begins November
Petrels	Bulwer's Petrel (Bulweria bulwerii) – LC	2	1	3	2	2					Marine and highly pelagic, usually found far from land except during the breeding season	Mainly fish and squid, less crustaceans and sea-striders, feeding largely at night by surface-seizing	Begins in April or May
Petrels	Black-winged Petrel (Pterodroma nigripennis) – LC	2	2	3	2	4					Marine and highly pelagic, avoiding land except during breeding	Cephalopods and prawns mainly by surface-seizing and dipping, also pattering.	Not known?
Petrels	Mottled Petrel (Pterodroma inexpectata) – NT	2	1	3	2	2					Marine and highly pelagic, trans-equatorial migrant	Squid and fish	Starts October
Petrels	Cook's Petrel (Pterodroma cookii) – VU	2	2	3	2	4					Marine and highly pelagic	Squid, crustaceans, fish and carrion – feeds by night.	Starts October-November
Petrels	Pycroft's Petrel (Pterodroma pycrofti) – VU	2	1	3	2	2					Marine and highly pelagic, forage over warmer water north of the sub-tropical convergence zone, mainly over deep water beyond the continental shelf. After breeding migrate to the tropical central Pacific to complete the annual feather moult	Squid and crustaceans.	Adults return October to clean burrows, egg-laying November-December, fledglings April-May
Petrels	Providence Petrel (Pterodroma solandri) – VU	2	1	3	2	2					Marine and pelagic, well beyond the continental shelf	Fish, squid, crustaceans and offal, recorded fishing at night also in groups	Starts March
Petrels	Bonin Petrel (Pterodroma hypoleuca) – LC	2	2	3	2	4					Marine and pelagic, rarely approaches land except at colonies	Feeds mostly at night on small fish and some squid, shrimps and sea skaters by dipping or surface-feeding on the ocean surface	Starts December
Petrels	Kermadec Petrel (Pterodroma neglecta) – LC	2	1	3	2	2					Marine and highly pelagic, rarely approaching land except at colonies	Squid and crustaceans have been recorded as prey	Variable
Petrels	White-necked Petrel (Pterodroma cervicalis) – VU	2	2	3	2	4					Marine and highly pelagic, often in areas of upwelling, rarely approaches land except at colonies	Squid and flying fish seized in air	Starts October-December
Shearwaters	Buller's Shearwater (Ardenna bulleri) – VU	3	2	3	2	4	3	1.3	2.9	2	Marine and pelagic	Fish, squid, crustaceans, may feed at night, attends trawlers	Starts in October
Shearwaters	Flesh-footed Shearwater (Ardenna carneipes) – NT	3	2	3	2	4					Marine and pelagic, mainly offshore over continental shelf	Mostly diurnal, squid and fish	Starts September-October
Shearwaters	Sooty Shearwater	3	2	3	2	4					Marine, generally cold offshore	Small shoaling fish,	Starts October

	(Ardenna grisea) – NT										waters	cephalopods, crustaceans, sometimes attends trawlers (mostly juveniles?)	
Shearwaters	Short-tailed Shearwater (Ardenna tenuirostris) – LC	3	2	3	2	4					Marine, inshore, offshore and to lesser degree pelagic waters, trans-equatorial migrant, during breeding season wanders over large areas of ocean	Fish (particularly mycotphids), crustaceans and squid, feeding in large groups, sometimes in vicinity of cetaeans	Starts October
Shearwaters	Streaked Shearwater (Calonectris leucomelas) – NT	3	1	3	2	2					Marine and partly pelagic	Fish and squid, follows fishing boats	Starts March
Shearwaters	Wedge-tailed Shearwater (Ardenna pacifica) – LC	3	1	3	2	2					Marine and pelagic, rarely approaching land except at colonies	Mostly fish, some cephalopods, minor quantities of insects and crustaceans, and offal	Variable
Shearwaters	Bryan's Shearwater (Puffinus bryani) – CR	3	1	3	2	2					Marine and pelagic	Not known	Boreal winter
Shearwaters	Christmas Shearwater (Puffinus nativitatis) – LC	3	1	3	2	2					Marine and pelagic, occurs over warm waters, generally keeping away from land	Fish and squid, minor proportions of crustaceans, mainly caught by pursuit-plunging and pursuit-diving, but also by surface-seizing.	Variable
Shearwaters	Bannerman's Shearwater (Puffinus bannermani) – EN	3	1	3	2	2					Marine, normally offshore but also pelagic and near land in vicinity of colonies	Fish, squid and cephalopods by surface-seizing, underwater pursuit, including diving and plunging, and pattering.	Not known?
Shearwaters	Tropical Shearwater (Puffinus bailloni) – LC	3	1	3	2	2					Marine, normally offshore but also pelagic, near land in vicinity of colonies	Mainly fish, squid and crustaceans	Variable; summer at higher latitudes
Shearwaters	Newell's Shearwater (Puffinus newelli) – CR	3	1	3	2	2					Marine, occurring in warm subtropical offshore and pelagic waters	Fish (flyingfish) and squid (Purpleback Flying Squid), hundreds of kilometres offshore, often in mixed species flocks associated with schools of predatory fish driving prey species to ocean surface	Starts in April
Skuas and Jaegers	South Polar Skua (Catharacta maccormicki) – LC	1	1	2	1	1	1	1.3	2.0	1	Not noted (range not likely)		
Skuas and Jaegers	Pomarine Jaeger (Stercorarius pomarinus) – LC	1	1	2	1	1					Marine outside the breeding season, remaining somewhat coastal, especially in upwelling regions of the tropics and subtropics	In winter, it takes fish, sometimes by kleptoparasitism, small seabirds, and carrion	
Skuas and Jaegers	Arctic Jaeger (Stercorarius parasiticus) – LC	1	1	2	1	1					Predominately coastal, but will migrate over land.	Most or all of its food is obtained by kleptoparasitism	Starts in May-June
Skuas and Jaegers	Long-tailed Jaeger (Stercorarius longicaudus) – LC	1	2	2	1	2					Marine and highly pelagic (winter), rarely occurring within sight of land except when breeding	Winter (marine) diet largely unknown, probably includes marine insects and fish, with some scavenging and kleptoparasitism	Starts June
Kittiwakes	Black-legged Kittiwake (Rissa tridactyla) – VU	1	2	1	0	0	0	2.0	1.0	1	Costal to oceanic	Squid, shrimps and fish, at sea during winter it often exploits sewage outfalls and fishing vessels	May-June
Gulls	Ross's Gull (Rhodostethia	1	1	2	1	1	1	1.0	2.0	1	Not noted (range not likely)		

	rosea) – LC												
Murres	Common Murre (Uria aalge) – LC	1	1	*1*	0	0	0	1.0	1.0	1	Marine (rocky shores), offshore during winter, along continental shelfs	Fish, invertebrates, fish eggs, dives usually to 20-80 m	Starts in spring, fledglings in July-August
Guillemots	Pigeon Guillemot (Cepphus columba) – LC	1	1	*1*	0	0	0	1.0	1.0	1	Not noted (range not likely)		
Guillemots	Spectacled Guillemot (Cepphus carbo) – LC	1	1	*1*	0	0					Not noted (range not likely)		
Auklets	Parakeet Auklet (Aethia psittacula) – LC	1	2	*2*	1	2	2	1.8	2.0	2	Marine, offshore (along coasts), mostly pelagic during winter	Planktonic crustaceans, juvenile fish, dives usually above 30 m	Period variable (spring-summer)
Auklets	Crested Auklet (Aethia cristatella) – LC	1	2	*2*	1	2					Marine offshore and along coasts, mostly pelagic in winter	Invertebrates, small fish and squid , forages in large flocks	Spring-summer
Auklets	Whiskered Auklet (Aethia pygmaea) – LC	1	1	*2*	1	1					Marine offshore and along coasts, sometimes pelagic in winter (large flocks)	Invertebrates, small fish and squid, forages in large flocks, dives not deeper than 100 m	Spring-summer
Auklets	Least Auklet (Aethia pusilla) – LC	1	2	*2*	1	2					Marine offshore and along coasts, pelagic where zooplankton concentrations are high (upwelling, tidal pumps)	Planktonic crustaceans, dives to 15-25 m	Spring-summer
Auklets	Rhinoceros Auklet (Cerorhinca monocerata) – LC	1	2	*2*	1	2					Marine offshore and along coasts, pelagic where food concentrations are high , large flocks	Fish (dives to pursuit schooling flocks), squid, crustaceans,	Spring-summer
Puffins	Horned Puffin (Fratercula corniculata) – LC	1	2	*1*	0	0	0	2.0	1.0	1	Marine along coast and offshore, winter to edge of continental shelf	Fish, squid, crustaceans, by underwater pursuit diving above 40 m	Spring-summer, fledglings September
Puffins	Tufted Puffin (Fratercula cirrhata) – LC	1	2	*1*	0	0					Marine along coast and offshore, winter moving off continental shelf to mid-ocean (low densities)	Small fish, cephalopods, crustaceans, by underwater pursuit diving above 40-50 m	Spring-summer, fledglings August-September
Boobys	Masked Booby (Sula dactylatra) – LC	1	1	*2*	1	1	1	1.0	2.0	1	Strictly marine species can normally be found over pelagic waters, preferring deeper waters than other boobies	Large species of shoaling fish, especially flying fish, but will also take large squid	Depending on latitude
Boobys	Brown Booby (Sula leucogaster) – LC	1	1	*2*	1	1					Strictly marine, generally feeding on inshore waters	Mainly flying-fish and squid, but also some halfbeak (Hemiramphu), mullet (Mugil) and anchovy (Engraulis), usually caught by plunge-diving, may also snatch prey off the surface	Variable
Boobys	Red-footed Booby (Sula sula) – LC	1	1	*2*	1	1					Strictly marine and largely pelagic	Mainly flying-fish and squid with a mean prey length of 8.8 cm, caught by plunge-diving, flying fish are also taken in flight, especially when chased by underwater predators	Not seasonal
Terns	Aleutian Tern (Onychoprion aleuticus) – VU	1	1	*1*	0	0	1	1.0	1.5	1	Mostly coastal	Not noted (range not likely)	
Terns	Sooty Tern (Onychoprion fuscatus) – LC	1	1	*2*	1	1					Dispersive and migratory, adults leave for the open sea after breeding and become strongly pelagic	Fish and squid, also crustaceans, occasionally insects and offal	Variable

Table 2. Marine mammal species included for risk analysis of exploratory fishing for Chub Mackerel within the NFCM Convention area, with background information concerning habitat, feeding, behaviour, and breeding used for classification of spatial overlap, catchability, and risk of mortality.

Family	**Preliminary species list of mammals (with IUCN classification)**	**ETP spp risk level_1_2_3**	**Spatial overlap_1_2**	***Catchability_1_2_3***	**Catchability_new**	**Risk_combined**	**Mean_est_risk_family**	**Mean_spatial_overlap_family**	**Mean_catchability_family**	**Risk**	**Habitat**	**Feeding**	**Behaviour**	**Breeding**
Porpoises	Dall's Porpoise (Phocoenoides dalli) – LC	1	2	3	2	4	4	2.0	2.0	2	Offshore deep waters	Night active. Opportunistic feeders, surface and midwater fish (lanternfishes, myctophids) and squid (especially soft-bodied gonatid squids)	Bow-riders, fast swimmers, usually in groups 2-12. May dive to 500 m. "Smaller incidental catches occur in several fisheries using gillnets and trawls in Russian, and US and Canadian west coast waters" (Jefferson ea 2015).	Calves born June-September
Dolphins	Pacific White-sided Dolphin (Lagenorhynchus obliquidens) – LC	1	2	3	2	4	3	2.0	2.0	2	Deep offshore waters, also extending to continental shelf (sometimes also closer to coast)	Mesopelagic and epipelagic small fishes (lanternfish, anchovies, sauries, horse mackerel, hake), deep scattering layer (DSL) organisms, as well as cephalopods.	Groups or large herds, lines when hunting. Also feeding frenzies near surface.	Births April-August
Dolphins	Common Dolphin (Delphinus delphis) – LC	1	2	3	2	4					Nearshore waters to thousands of kilometers offshore, strong preference for upwelling-modified waters and areas with steep sea-bottoms	Squid and small epipelagic schooling fish. In e.g. S California, common dolphins feed mostly at night on DSL creatures which migrate toward surface at night.	Herds from about ten to over 10,000. Taken in many fisheries worldwide. Some direct mortality (from hunting) still occurs off Japan. Incidental catches in various fisheries including pelagic trawls. In the eastern tropical Pacific sometimes associated with yellowfin tuna in purse-seine fishery.	Variable?

Dolphins	Rough-toothed Dolphin (Steno bredanensis) – LC	1	1	3	2	2					Deep oceanic waters of all three major oceans	Cephalopods and fishes, including large fish (e.g. dorado).	Most commonly in groups of 10 – 20, over 100 reported. May be slow-moving, at other times move at high speed ("surfing"), sometimes bowride and may opportunistically feed around trawlers. Dives up to 15 min. Sometimes taken as bycatch in purse seine fisheries for tuna (eastern tropical Pacific), and in gillnet fisheries in the offshore North Pacific.	Not much known
Dolphins	Spinner Dolphin (Stenella longirostris) – LC (Gray's spinner dolphin (S. l. longirostris)	1	1	3	2	2					Range over vast distances of open ocean in search of suitable patches of preybut often rest in coastal or shallow waters (e.g. bays of oceanic islands and coral atolls).	Feed predominantly at night, on small (<20 cm) midwater fishes of many different families (including myctophids), squids, and sergestid shrimps.	Herd sizes range from less than 50 up to several thousand. Active bowriders, move offshore in the late afternoon/evening for nighttime feeding (mostly near dusk and dawn) in continental slope and oceanic waters. Mostly feed in shallower waters but may dive to 600 m.	Depending on populations' range, calving peaks from late spring to autumn.
Dolphins	Striped Dolphin (Stenella coeruleoalba) – LC	1	2	3	2	4					Generally restricted to oceanic regions; seen close to shore only where deep water approaches the coast. Range extends into temperate regions with extralimital records from the Kamchatka Peninsula.	Feed in pelagic to benthopelagic zones, at continental slope or oceanic regions, on a wide variety of small, midwater and pelagic or benthopelagic fish (lanternfish, cod), and squid.	Fast swimmers, often bowride. Herds usually between a few dozen and 500 individuals. Thought to be capable of diving to depths of 200 – 700 m to obtain prey.	Two calving peaks: summer and winter (Japan)
Dolphins	Pantropical Spotted Dolphin (Stenella attenuata) – LC	1	1	3	2	2					Much more abundant in the lower latitude portions of range. Primarily inhabits waters with a sharp, shallow thermocline and surface water temperatures of over 25°C.	Small epi- and mesopelagic fishes, squids, and crustaceans (DSL). In some areas, flyingfish are important.	Fast swimmers, bowride. Taken incidentally in a number of fisheries, including trawls.	Two calving peaks (Eastern Tropical Pacific), one in spring and one in autumn

Dolphins	Fraser's Dolphin (Lagenodelphis hosei) – LC	1	1	3	2	2					Oceanic, prefers deep offshore waters.	Feed on midwater fish (especially myctophids), squid, and crustaceans.	Believed to mostly feed deep in the water columndiving up to 600 m, but have been observed to feed near the surface.	Calving peaks in spring and autumn (Japan)
Dolphins	Northern Right Whale Dolphin (Lissodelphis borealis) – LC	1	2	3	2	4					Deeper waters from the outer continental shelf to oceanic regions	Surface and mesopelagic fish (lanternfish, hake, sauries), squid and cephalopods.	Schools 100-200 individuals (up to 3000 have been seen), some herds very tightly packed. Dives up to 6.5 min. "... large number of specimens killed in the North Pacific squid driftnet fisheries" (Jefferson ea 2015).	Calving peak July-August
Dolphins	Risso's Dolphin (Grampus griseus) – LC	1	2	3	2	4					Deeper waters of the continental slope and outer shelf (especially at steep topography), also at lower densities in oceanic areas beyond the slope	Crustaceans and cephalopods (squid and octopus preferred).	Often slow-moving, occasionally bowriding. Moderately sized herds 10-400. Lines when hunting. Dives to 300 m. "incidental catches in several fisheries ... also in purse seines" (Jefferson ea 2015).	Calving peak summer-autumn (off Japan)
Dolphins	Killer Whale (Orcinus orca) – DD	1	2	3	2	4					Any marine region, at higher latitudes most commonly where waters are most productive	Great diversity of feeding strategies, mammals and fish, group hunting.	May show interest in vessels, at other times avoid them. Often travel in a line when resting.	Calving peak October-March
Dolphins	Short-finned Pilot Whale (Globicephala macrorhynchus) – LC	1	1	3	2	2					Oceanic	Not noted (range not likely)		
Dolphins	Melon-headed Whale (Peponocephala electra) – LC	1	1	3	2	2					Mostly oceanic waters.	Squid and small fish, appear to feed mainly deep in the water column.	Common in herds of 100 – 500 individuals, often seen swimming with other species (Fraser's dolphins). Often move at high speed, eager bowriders. Often seen in large schools of rafting individuals in calm waters (tropical archipelagos). Sometimes involved in mass strandings.	Indication of a calving peak in July and August

Dolphins	Pygmy Killer Whale (Feresa attenuata) – LC	1	1	3	2	2					Oceanic waters around the globe. Rarely seen nearshore but may occur around oceanic islands (deep and clear water).	Mostly fish and squid. Feeding appears to occur mostly at night (at least in Hawaii).	Groups generally contain about 12 – 50 individuals. Mostly slow moving, does not generally bow ride.	Not much known
Dolphins	False Killer Whale (Pseudorca crassidens) – NT	1	2	3	2	4					Deep, offshore waters, sometimes occur over the continental shelf.	Fish (some large species of fish, such as mahi mahi, wahoo, billfish, and tunas), and cephalopods. (Have been known to also attack other cetaceans.)	Groups of 10 – 60 are typical. Fast-swimming, occasionally bowrides.	No distinguished seasonality
Beaked whales	Hubbs' Beaked Whale (Mesoplodon carlhubbsi) – DD	2	1	1	0	0	0	1.7	0.0	1	Deep oceanic waters, distribution thought to be across the North Pacific	Squid and some deepwater fishes	Little known	Calving mainly summer months
Beaked whales	Cuvier's Beaked Whale (Ziphius cavirostris) – LC	2	2	1	0	0					Widespread distribution, offshore waters	Feeds mostly in deep water on deep-sea squid, sometimes fish and crustaceans	Groups of 2-7, or alone. Record-holder for deep diving among mammals (occasionally caught in deep water drift gillnets).	Seasonality not observed
Beaked whales	Stejneger's Beaked Whale (Mesoplodon stejnegeri) – DD	2	2	1	0	0					Continental slope and oceanic waters of the North Pacific Basin	Mesopelagic and bathypelagic zones, primarily squids, also some fish	Groups of 5 – 15 individuals may be tightly bunched at the surface. Presumably deep divers.	Calving spring to early autumn
Beaked whales	Baird's Beaked Whale (Berardius bairdii) – DD	2	2	1	0	0					Over or near continental slope and near oceanic seamounts	Much feeding at depths of 800-1,200 m, mainly deepwater and bottom-dwelling gadiform fish, cephalopods, crustaceans, as well as pelagic fish (mackerel, sardines, and saury).	Groups of 5–20 whales common (occasionally up to 50). Often drift in tight groups at the surface. Deep divers.	Calving peak March-April
Beaked whales	Indo-Pacific Beaked Whale (Indopacetus pacificus) – DD	2	1	1	0	0					Mainy in deep oceanic waters in the tropical to subtropical Indo-Pacific; sightings in areas with surface water temperatures of 21 – 31°C.	Little known, presumably primarily feeding on cephalopods.	Large, coordinated herds of 10-100 individuals, often swim in tight groups, may dive up to at least 33 minutes.	Virtually nothing known

Beaked whales	Blainville's Beaked Whale (Mesoplodon densirostris) – DD	2	2	1	0	0					Mostly offshore in deep waters of temperate and tropical waters.	Mainly squid, but some deepwater fish. Thought to be suction feeders.	Mostly in singles or pairs, groups of 3-7 have been recorded. "Harems" occur in waters over the continental shelf or canyon walls. May dive to 1,400 m (over 54 minutes), but also spend long periods in upper water layers (<50 m).	Variable?
Sperm whales	Sperm Whale (Physeter macrocephalus) – VU	2	2	1	0	0	0	2.0	0.0	1	Oceanic waters deeper than 1,000 m, over continental slope, in higher densities in certain areas of high productivity, often near steep drop-offs and areas with strong currents, occasionally over the continental shelf in specific areas or closer to shore where physical features bring up deep water	Seize individual prey items of mainly cephalopods (among them giant squid), also deep-sea fish (lumpsuckers, redfishes)	Extremely deep and long divers, during foraging commonly about 400 m (capable of reaching depths of >3,200 m), rafting (lying nearly motionless at surface) is common after dives	Most births occur summer-autumn
Sperm whales	Pygmy Sperm Whale (Kogia breviceps) – DD	2	2	1	0	0					Deep, tropical to warm temperate oceanic waters (outer continental shelf and beyond), more common over and near continental slope.	Feeds in deep water, primarily on cephalopods and, less often, on deep-sea fishes and shrimps.	Appear slow and sluggish, often raft motionless at the surface. Presumably deep divers (feed on deep-sea fishes).	Not known?
Rorquals	Humpback Whale (Megaptera novaeangliae) – LC	2	2	1	0	0	0	1.8	0.0	1	Over continental shelves of all the continents, migrating to temperate and polar summer grounds, often through oceanic zones	Krill and small schooling fish (herring, sand lance, mackerel, sardines, anchovies, capelin). Adaptable lunge-feeders, in some areas use bubble nets and other techniques to concentrate prey, may use cooperative feeding techniques.	Generally occur alone or in small groups, larger aggregations in feeding and breeding areas. Migrations among the longest known for mammal species(up to 8,000 km one-way), one reason is to take advantage of highly productive summer blooms of high latitudes.	Calves born on wintering grounds (tropica/subtropical regions)

Rorquals	Fin Whale (Balaenoptera physalus) – VU	2	2	1	0	0					Primarily oceanic waters of all major oceans. Most populations are apparently migratory, overall range and distribution not well known.	Generalists, mostly feeding on small crustaceans, sometimes schooling fish (capelin, herring, mackerel, sandlance, blue whiting), and squid. Active lunge feeders.	One of the fastest great whales. Sometimes gathering in pods of 2 – 7 whales, or more.	Calves born on wintering grounds (tropica/subtropical regions)
Rorquals	Blue Whale (Balaenoptera musculus) – EN	2	2	1	0	0					Open ocean, may be seen closer to shore.	Krill (euphausiids) form major part of diet. Lunging.	Usually alone or in pairs, scattered aggregations may develop on prime feeding grounds.	Calves born on wintering grounds (tropica/subtropical regions)
Rorquals	Bryde's Whale (Balaenoptera edeni) – LC	2	1	1	0	0					Open ocean	Not noted (likely not in range)		
Rorquals	Omura's Whale (Balaenoptera omurai) – DD	2	1	1	0	0					Exact range not well established, apparently restricted to tropical and subtropical waters, mostly over the continental shelf in relatively nearshore waters.			
Rorquals	Sei Whale (Balaenoptera borealis) – EN	2	2	1	0	0					Open ocean, irruptive occurrence	Prefer to feed near dawn, skimming copepods and other small prey types, occasionally lunging (krill, cephalopods, sardines, anchovies).	Fast swimmers. Two to five individuals most commonly seen.	Calving in midwinter, at low latitudes of species' range
Rorquals	Common Minke Whale (Balaenoptera acutorostrata) – LC	2	2	1	0	0					Offshore and coastal areas	A variety of prey species according to availability (anchovy, saury, sandlance, walleye pollock, krill, squid)	Generally alone or small group sizes, larger groups may aggregate on productive feeding grounds. Appear to have a complex social structure. Often approach and swim around stationary vessels.	Calving in midwinter, at low latitudes of species' range
Rorquals	North Pacific Right Whale (Eubalaena japonica) – EN	2	2	1	0	0					Previously extensive distribution in offshore waters (>2,000 m water depth), now extremely rare in North Pacific. Historical evidence of northward migration in spring and a southward shift in	Slowly skimming either near surface or at depth for calanoid copepods and other small invertebrates (krill, pteropods, larval barnacles).	Generally occur as singles or pairs. Larger aggregations may form on feeding grounds. Peaks in call detections shown to coincide with high copepod abundance.	Absence from coastal areas in winter may suggest offshore breeding (breeding grounds not known).

											autumn.			
Earless seals	Northern Fur Seal (Callorhinus ursinus) – VU	2	2	3	2	4	3	1.5	2.0	1	Foraging relatively far from shore (mean trip length about 7 days), over the edge of the continental shelf and slope. Adults at sea most of the year. Especially juveniles migrate from the Bering Sea south into the North Pacific for winter feeding.	Epipelagic and vertically migrating mesopelagic schooling and non-schooling fish (anchovy, hake, saury, rockfish, salmon, walleye pollock, capelin, sand lance, herring, Atka mackerel) and squid. Foraging areas are often correlated with oceanic eddies and fronts in areas of surface waters with high cholorphyll.	Diving very active at dawn and dusk, otherwise rafting at the surface, sleeping or grooming. Mean depth of dives about 70 m. Most likely encountered alone or in pairs.	Breeding mid-June through August
Earless seals	Spotted Seal (Phoca largha) – LC	2	1	3	2	2					Usually dweling on sea ice, may become pelagic and range widely in late summer and autumn	Varied diet; small crustaceans, schooling to bottom dwelling fish (walleye pollock, Arctic cod, sand lance, capelin, saffron cod), larger crustaceans, and octopuses.	Haul out to sea in small aggregations. "Triads" are common (a female with her pup and a male).	Breed almost exclusively on sea ice, usually January to mid-April, pupping mid- to late March
Earless seals	Harbor Seal (Phoca vitulina) – LC	2	1	3	2	2					Widespread in coastal areas, mainly found from coast to continental slope. May become pelagic and range widely in late summer and autumn.	A wide variety of fish, cephalopods, and crustaceans from surface, mid-water, and benthic habitats	Foraging trips can last for several days. Average dives to <35 m (maximum recorded depth of 800 m). May be curious to peer at people.	Mating usually in the water February-October, pupping peaks April-July
Earless seals	North Pacific Harbor Seal (Phoca vitulina ssp. richardii) – LC	2	2	3	2	4					North Pacific, e.g. along Kamchatka and south to Hokkaido, Japan.	A wide variety of fish, cephalopods, and crustaceans from surface, mid-water, and benthic habitats	Foraging trips can last for several days. Average dives to <35 m (maximum recorded depth of 800 m). May be curious to peer at people.	Mating usually in the water February-October, pupping peaks April-July
Earless seals	Kuril Seal (Phoca vitulina ssp. stejnegeri) – DD	2	2	3	2	4					Western North Pacific, Kuril Islands (SW of Kamchatka).	A wide variety of fish, cephalopods, and crustaceans from surface, mid-water, and benthic habitats	Foraging trips can last for several days. Average dives to <35 m (maximum recorded depth of 800 m). May be curious to peer at people.	Mating usually in the water February-October, pupping peaks April-July

Earless seals	Ribbon Seal (Histriophoca fasciata) – LC	2	1	3	2	2					Inhabit southern edge of pack ice winter-early summer (prefer ice from continental slope out over deeper oceanic areas). Thought to be pelagic (mostly Bering Sea) during summer, and records from the North Pacific indicate a wider range during summer.	Varied diet (overall diet not known); small crustaceans, many different fish species, larger crustaceans, squid, and octopuses.	Solitary for much of their lives. Little known.	Pups born on ice floes early April-early May
Eared seals	Steller Sea Lion (Eumetopias jubatus) – NT	2	2	3	2	4	4	2.0	2.0	1	From coast to the outer continental shelf and slope where they feed. Frequently cross deep oceanic waters in some parts of their range	Variety of fish and invertebrates (walleye pollock, Pacific cod, Atka mackerel, herring, sand lance, several varieties of flatfish, salmon, rockfish), squid, octopus, bivalves, gastropods etc. Adult females with young pups feed extensively at night.	Mostly groups of 1 – 12 animals, aggregate in areas of prey abundance, including near fishing vessels. Diving is generally to 200 m or less (up to 400 m).	Breed late spring and summer, pups born May-July
Walruses	Northern Elephant Seal (Mirounga angustirostris) – LC	1	1	1	0	0	0	1.0	0.0	1	Postbreeding and post-molt migrations north and west to oceanic areas of the North Pacific and Gulf of Alaska twice a year, with some reaching the Aleutian Islands chain (to 178°W). Vagrants have found as far away as Japan and Midway Island.	Not noted (likely not in range)		
Walruses	Pacific Walrus (Odobenus rosmarus divergens) – DD	1	1	1	0	0					Relatively shallow continental shelf areas, and rarely occur in deeper waters.	Not noted (likely not in range)		

References

Avila, I.C., Kaschner, K. and Dormann, C.F. 2018. Current global risks to marine mammals: taking stock of the threats. Biological Conservation 221: 44-58.

del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. & Kirwan, G. (eds.) 2019. Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. (retrieved from http://www.hbw.com/ [February/2019]).

Froese, R. and D. Pauly. Editors. 2018. FishBase. World Wide Web electronic publication. www.fishbase.org, version (10/2018).

IUCN 2018. The IUCN Red List of Threatened Species. Version 2018-2. http://www.iucnredlist.org Downloaded February 2019.

Jefferson, T. A., Webber, M. A. and Pitman, R. L. 2015. Marine Mammals of the World (Second Edition). San Diego, Academic Press.

Perez, M.A. 2006. Analysis of Marine Mammal Bycatch Data From the Trawl, Longline, and Pot Groundfish Fisheries of Alaska, 1998-2004, Defined by Geographic Area, Gear Type, and Catch Target Groundfish Species. U.S. Department Of Commerce, NOAA, National Marine Fisheries Service, Alaska Fisheries Science Center.

Shirihaai, H., Jarrett, B. 2006. Whales, dolphins and seals – A field guide to the marine mammals. London, A & C Black Publishers.