Monterey Bay Aquarium
Seafood Watch

Environmental sustainability assessment of wild-caught Argentine shortfin squid (*Illex argentinus*) from the Southwest Atlantic Ocean caught using jigs

Species:	Argentine shortfin squid (*Illex argentinus*)
Location:	Southwest Atlantic Ocean (High Seas)
Gear:	Jig
Type:	Wild Caught
Author:	Seafood Watch
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Assessed using Seafood Watch Fisheries Standard v3

Table of Contents

About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Watch Assessment. Each assessment synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, Seafood Watch seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying assessments will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Watch assessments in any way they find useful.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard. Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught, farmed or managed.

Avoid/Red: Take a pass on these for now; they're overfished, lack strong management or are caught or farmed in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report provides a recommendation for Argentine shortfin squid (*Illex argentines*) captured in the Southwest Atlantic high sea by China and Taiwan squid jig fleets, and Falkland Islands' FICZ/FOCZ by Taiwan squid jiggers (FICZ: Falklands Interim conservation & Management Zone; FOCZ: Falkland Outer Conservation Zone). Argentina, South Korea, Spain, and other countries also take squid in the South Atlantic Ocean or own countries' jurisdictions. China and Taiwan together harvested about 56% of globally overall Argentite shortfin squid product based on the 2016 FAO statistics {FAO Fisheries and Aquaculture Department 2019}.

Argentine shortfin squid is one of the most important commercial squid resources in the world and its distribution mainly across the Argentinean/Uruguayan/Falkland Island offshore and SWA High Sea. As a short life span species, its longevity is generally less than 2 years. The hatched paralarva will conduct foraging migration follow the currents then move to the spawning ground for reproduction after which most of the squid will die. Argentine shortfin squid populations are influenced by environmental parameters and fishing effort. There is a lot of research that concentrates on understanding how environmental factors together with fishing behaviors influence the stock variation while only limited knowledge regarding this area is obtained.

Due to short of resources monitoring and management in the Southwest Atlantic high seas, the high seas shortfin squid gets heavily exploited without limitation and the overall squid fishing mortality is in an unknown status as a transboundary migration species. Management efforts are only available from countries' EEZ that squid migrates in, like Argentina, Falkland Island in different manners while shortfin squid as a straddling resource means cooperation efforts are needed for manage such migratory species. Furthermore, the squid recruitment mechanism and relevant biological characteristics are without a clear understanding by current research. Regional research found the main high seas squid stock was not overfished and harvested lower than F_{MSY} between 2000 to 2010. There is no stock data after 2010 and the 2010-2019 FAO China and Taiwan shortfin squid landing data showed fluctuation which indirectly indicates the squid stock biomass suffered variation as well. This circumstance confirmed that squid biomass is impacted by both environmental change and fishing behaviors. Currently, there is no clear overfishing/overfished evidence for the assessed fisheries is existing and even though under the short of management background, the squid harvest production still be able to rebound indicates the highly resilient biological characteristic while the harvest data in recently years rested on a relatively historical low level.

Even if squid jigging is a highly selective gear, it is possible to bycatch species that living in the same zone. the data published by Falkland government showed *illex* jigging fisheries have certain bycatch concern for seabird species. No by-catch of other species is found. The overall bycatch situation on SWA high seas jigging is without management or monitoring currently.

There is no management, monitoring or survey in the SWA high seas squid resources. Once an RFMO, South Atlantic Fisheries Commission (SAFC) was able to play such role but it was disbanded in 2005 and no management/regulation is available since that time. Falkland island and other regions do conduct relevant management measures for shortfin squid fishing inside respective EEZ but no enough to conserve and maintain sustainable utilization of the resources consider its migratory property. Due to lack of regulation in SWA high sea squid jigging, IUU cases happen occasionally and joint management efforts are imperative in the future not only for squid resources conservation but also for maintaining the marine ecosystem balance in SWA Ocean.

The assessed jig fishery usually takes place at seawater from 0 to 50 meters deep and jig gear is unable to contact sea bed or bring a negative impact to the benthic ecosystem. Argentine shortfin squid is also the crucial food web element in the SWA marine ecosystems at a macro-scale level through the transferal of substantial biomass and nutrients maintaining its function. However, due to lack of management in the SWA high sea, a higher level of management, ecosystem-based management is also missing for the target fisheries and squid fisheries' impact on the entire SWA ecosystem understanding is shorting as well.

In summary, the jigging fisheries for China and Taiwan SWA *illex* are be rated as Red/Avoid alternative due to lack of effective resource management, stock concern and unregulated fishing operation in the high seas fishing despite the squid's high variation characteristic means its biomass might able to rebound under no management background and

jigging is a highly selective fishing gears bring less negative impact to the Ocean.

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1 TARGET SPECIES	CRITERION 2 OTHER SPECIES	CRITERION 3 MANAGEMENT	CRITERION 4 HABITAT	OVERALL RECOMMENDATION
Argentine shortfin squid | Southwest Atlantic | Jig	2.644	2.236	1.000	3.162	**Avoid (2.079)**

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This report provides recommendations for the commercially important species *Illex argentines*, harvested by Taiwan and China (mainland China) vessels in the Southwest Atlantic (SWA) Ocean. The assessed species is fished on a large-scale using vertical lines in the Southwest Atlantic Ocean; in the high seas area and in Falkland Islands' exclusive economic zone. Besides the jig fishing operation, the Argentine shortfin squid is also harvested by trawler or as bycatch in other types of fisheries operating in the same areas. These squid harvests are out of scope in this assessment. Notably, there are additional countries conducting squid jigging in the SWA High Seas; these countries are not discussed in this assessment.

Species Overview

Cephalopod resources are recognized by FAO as some with the greatest potential for increased production in the future within the context of decreasing marine resources (Figure 1)(Chen Xin-jun. et al. 2012). Several cephalopods species are harvested commercially due to their relatively large harvestable volume; species include Japanese flying squid (*Todarodes pacificus*), Neon flying squid (*Ommastrephes bartramii*), Argentine shortfin squid (*Illex argentines*), Jumbo flying squid (*Dosidicus gigas*), *and* New Zealand arrow squid (*Nototodarus sloani*). The assessed species, Argentine shortfin squid is the second-largest cephalopod fishery in the world (Barratt and Allock 2014).

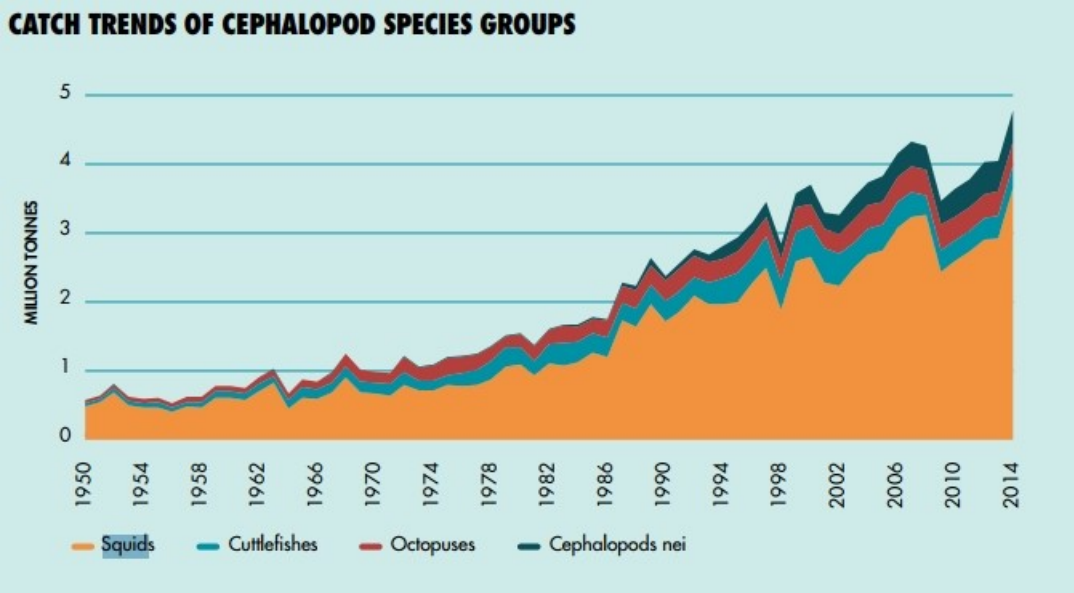

Figure 1: Global Cephalopod Capture Production (tons) (Data from FAO 2016(FAO 2016))

I. argentines (Argentine shortfin squid)

Argentine shortfin squid is a relatively small squid species, ranging from Brazil to Argentina in inshore areas. It occurs from the surface to about 800-meter depth, mainly concentrates on from 50-200 meters depth continental shelf (FAO 2019)(Yan Liu. et al. 2012). Argentine shortfin squid is generally fast growing and reaches an average length of about 40cm after one year. Females usually grow faster than males. Its longevity is generally less than 2 years (FAO 2019). It usually reaches sexual maturity at a total length of about 24 cm. Categorizing by the spawning ground location, the Argentine shortfin squid stock can be separated into four cohorts, which are the South Patagonian (SPS), the Bonaerensis/North Patagonian (BNS), the Summer Spawning (SSS) and the Spring Spawning (SpSS)/South Brazil Spawning (SBS) (Hua-jie Lu. et al. 2010). The South Patagonian Stock (SPS) inhabits the outer shelf and slope south of 44ºS and spawns on the slope between 45ºS to 48ºS in the winter months; the Bonaerensis-North Patagonian Stock (BNPS) is distributed north of 43ºS up to the Malvinas (Falkland)/Brazil currents convergence, presumably spawns in late winter on the western side of the convergence; the Summer Spawning Stock (SSS) lives and spawns on the mid and outer shelf between 42ºS and 46ºS from December to February; and the Spring Spawning Stock (SpSS) is found in mid-inner shelf between 38ºS and 41ºS {Fernández Cynthia. et al. 2019}(Brunetti 1988); (Haimovici et al. 1998); (Abril et

al. 2008; Haimovici et al. 1998). Argentine shortfin squid stock can also be categorized in different cohorts based on life characteristics or hatching season which were found in literature review(Hua-jie Lu. et al. 2010). Argentine shortfin squid stock is proved without gene-level difference among four categorized cohorts. Argentine shortfin squid preys on various marine creatures, from crustaceans, cephalopods (cannibalism) to fin fish, species like Argentine hake (*Merluccius hubbsi*) and Argentine anchovy *(Engraulis anchoita)* are common in its diet. It also plays as the prey for many high-trophic-level creatures in marine ecosystem, species like Bigeye tuna (*Thunnus obesus)*, Atlantic wreckfish (*Polyprion americanus)* and Swordfish (*Xiphias gladius)* are the predators for the Argentine shortfin squid (Hua-jie Lu. et al. 2010) (Rodhouse, Paul G.K. et al. 2013).

Argentine shortfin squid conduct diurnal foraging migrations. The squids concentrate close to the seabed during daytime and move to the surface at night time for feeding. Argentine shortfin squid also conducts long-distance migration for foraging and reproduction purposes (Hua-jie Lu. et al. 2010). In general, four squid cohorts have different migration routine. For example, SPS stock usually spawns and hatch in 28~38°S area, after that, the juveniles follow the warm Brazil current to 38~50°S continental slope for foraging then northward return to spawning ground to complete the life circle (Figure 2)(Na Li. et al. 2017). Argentine shortfin squid produce 8000 to 750000 eggs based on dissection analysis from the literature review (Laptikhovsky, V.V. et al. 1993). As a short-lived species, where the next year biomass is completely reliant on previous year's reproduction, its annual biomass variation is not only influenced by the human fishing activities but also by environmental factors such as sea surface temperature (SST), chlorophyll A level, sea height, and salinity. The SST parameter is considered as one of the crucial indicators to influence the squid distribution and fishing ground movement (Long Zhang. et al. 2013). Much research focuses on using historical fisheries data and modeling to understand how the environmental factors affect the squid stock, while research outcomes differ and there are uncertainties in understanding the importance of different variables, which indicates further research effort is needed (Hua-jie Lu. et al. 2010)(Na Li. et al. 2017).

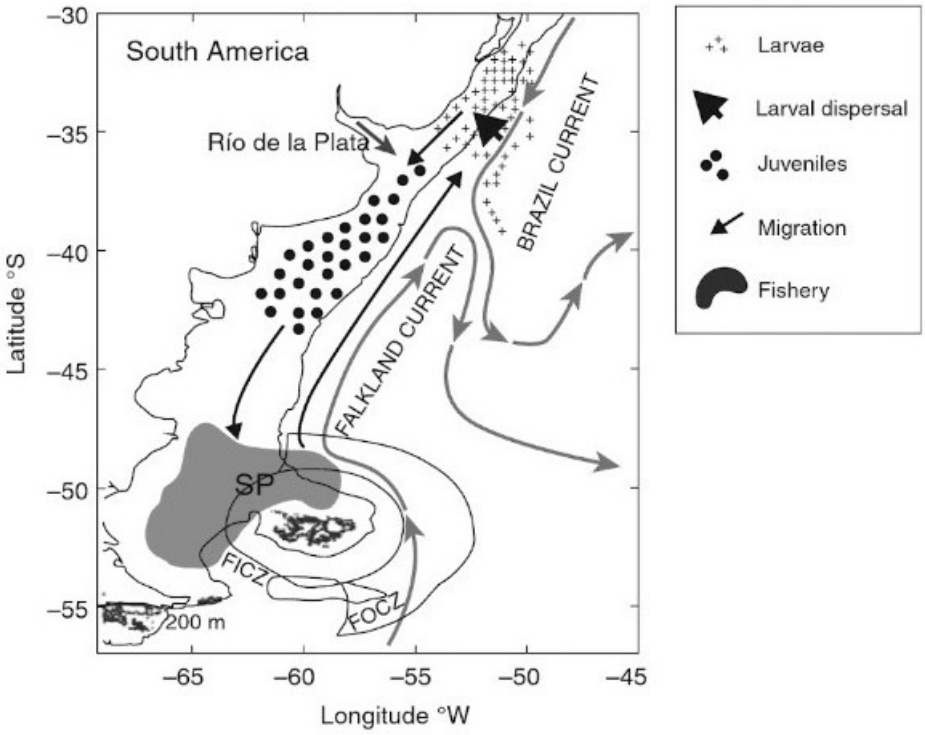

Figure 2: Life history and the migration pattern of the South Patagonian stock of the Argentine shortfin squid in the SWA Ocean

As a trans-boundary species, Argentine shortfin squid migrates among different countries' EEZ and high seas. The management of Argentine shortfin squid requires cooperation efforts not only from each surrounding country but also with countries active within the high seas fishery. The Chinese and Taiwanese squid jigging vessels are mainly operating in the Southwest Atlantic high seas area with a small number of Chinese vessels fishing in the Argentine EEZ under China-Argentina bilateral cooperation agreement (Dong-dong Yue. et al. 2014){Fu, Xiao-yin. 2016}. The Argentine shortfin squid is harvested by many countries. It is also harvested by Falkland, Uruguay, and Brazil via trawls or vertical

lines in respective EEZ, meanwhile be fished by Spain, South Korea via vertical lines in the high seas (Angel Alvarez Perez Jose. et al. 2010)(Falkland Islands Fisheries Departments 2019)(Arkhipkin, A. I. et al. 2015). There is currently no Regional Fisheries Management effort or regulations in place for the shared resources in Southwest Atlantic high seas. Once there was an RFMO formulated by the Argentinean and British government in the 1990s called South Atlantic Fisheries Commission (SAFC) to manage the fisheries resources within a disputed sovereignty sea zone and shared high seas but the Argentinians disengaged from their relationship with the SAFC in 2005 due to disagreements with the Falkland fishing license system reform {Fernández Cynthia. et al. 2019}.

Figure 3: Distribution maps for I. argentinus (Data source: FAO 2018(FAO 2019))

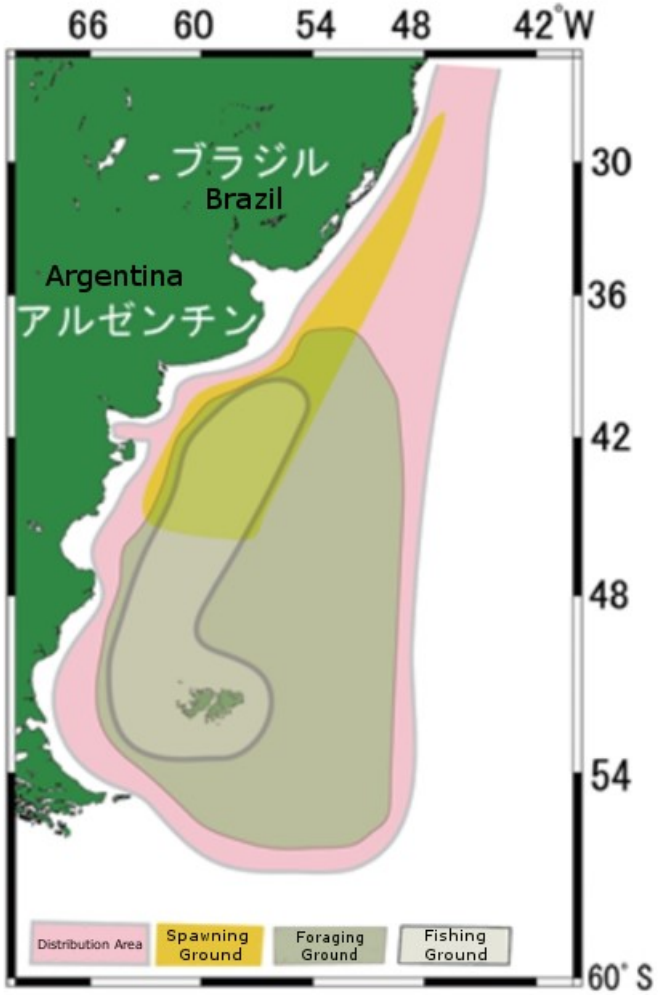

Figure 4: Main distribution area (pink) and presumed spawning grounds (yellow) of I. argentinus (Japan Fisheries Agency 2018a)

Production Statistics

The global harvest volume of Argentine Shortfin squid in 2014 was 862,867 tons. Since 2015, the Argentine Shortfin Squid harvest volume declined dramatically and has recovered slightly in recent years. Commercial harvest of Argentine shortfin squid is led by Argentina as the biggest single country in the SWA Ocean, which caught more than 100,000 tons of Argentine shortfin squid in 2017. China and Taiwan, which are the assessment units in the report also landed a significant volume. There are not existing species-level production statistics for the China high sea fisheries statistics only single calculation data of 519,721 tons of overall squid. That included Argentine shortfin squid and other squid species. Taiwan, on the other hand, maintains detailed official statistics. The total catch of Taiwanese high seas squid jigging fishery was 82,130 MT in 2017, with a production of Argentine shortfin squid at 73,728 MT, accounting for 89.8% of the total TW high seas squid jigging production. Taiwan and China are not only consuming the squid domestically but also trading the processed squid products into the international markets, mainly the E.U., U.S., and SE Asia.

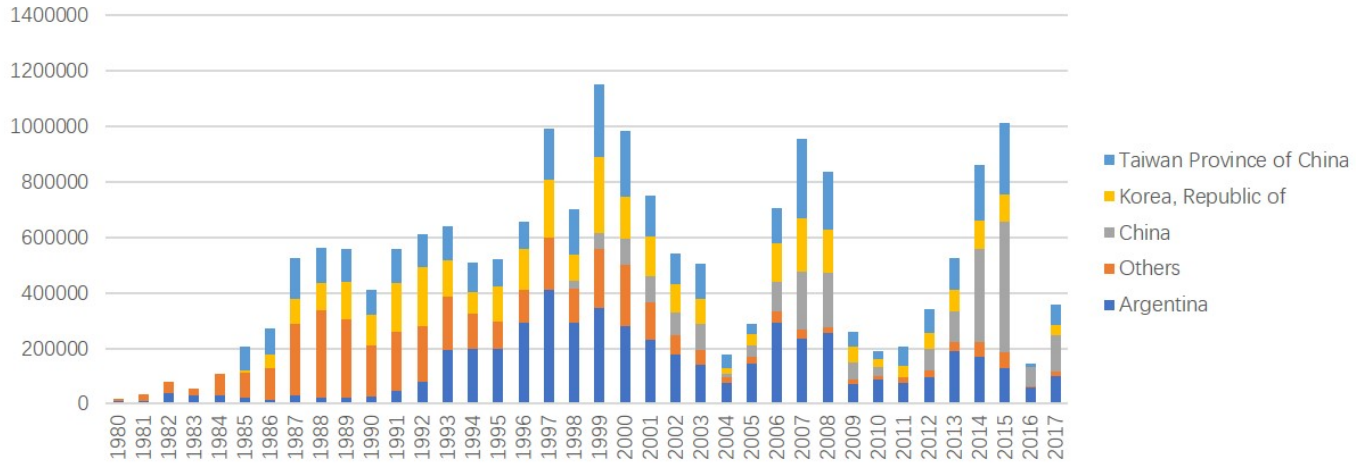

Figure 5: The FAO Argentine shortfin squid harvest volume from 1980-2017 for main exploited countries (Units: MT, Data source: FAO FishstatJ)

Importance to the US/North American market.

The 1980-2017 United States imported squid volume is shown in Figure 6. China and Taiwan were ranked No.1 and 2 for the U.S. imported squid products. China contributed more than 50% of the squid imported into the US in 2017, followed by Taiwan with 7510 tons of squid (27.5% of the U.S total squid imports) (Figure 6).

The imported squid products from China/Taiwan are categorizing by NMFS as ***Loligo* NSPF** or **squid NSPF** thus species-level statistics data are unavailable. The *Loligo* NSPF usually includes Chinese domestic harvest of *Loligo* and re-exported *Loligo* squid (*Loligo pealei* and *Loligo opalescens*), which account for 31.1% and 4.9%% of total China exported squid volume in 2017. Squid NSPF, which accounted for 61.8% of total China exported squid volume in 2017, cover squid species that China harvested from high seas or brought from other countries. This number includes the assessed Argentine shortfin squid while the detailed species-level statistics are unavailable. For the squid NSPF products sourced from Taiwan, cross-referencing with the Taiwan Fisheries statistical yearbook found that most of the squid products exported to the U.S are Argentine shortfin squid and Jumbo squid. Taiwan also exported a small percentage of *loligo spp.* (should be the domestic harvest), Loligo NSPF and *Loligo pealei* (should be the re-exported *loligo*) products to the U.S., which accounted for 7%, 5% and 2% of total 2018 Taiwan squid export volume to the U.S(Figure 8).

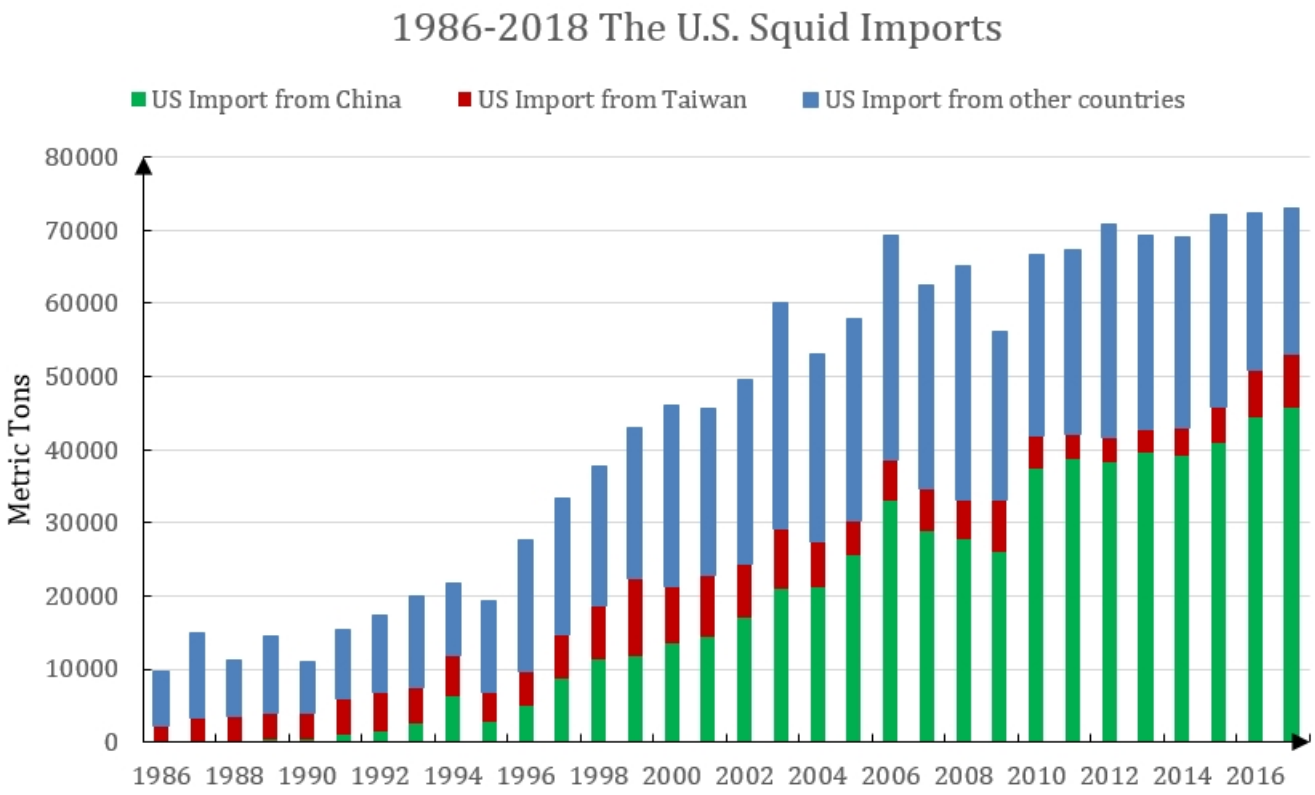

Figure 6: Total U.S. squid Imports 1986 – 2017 (NOAA Office of Science and Technology 2019)

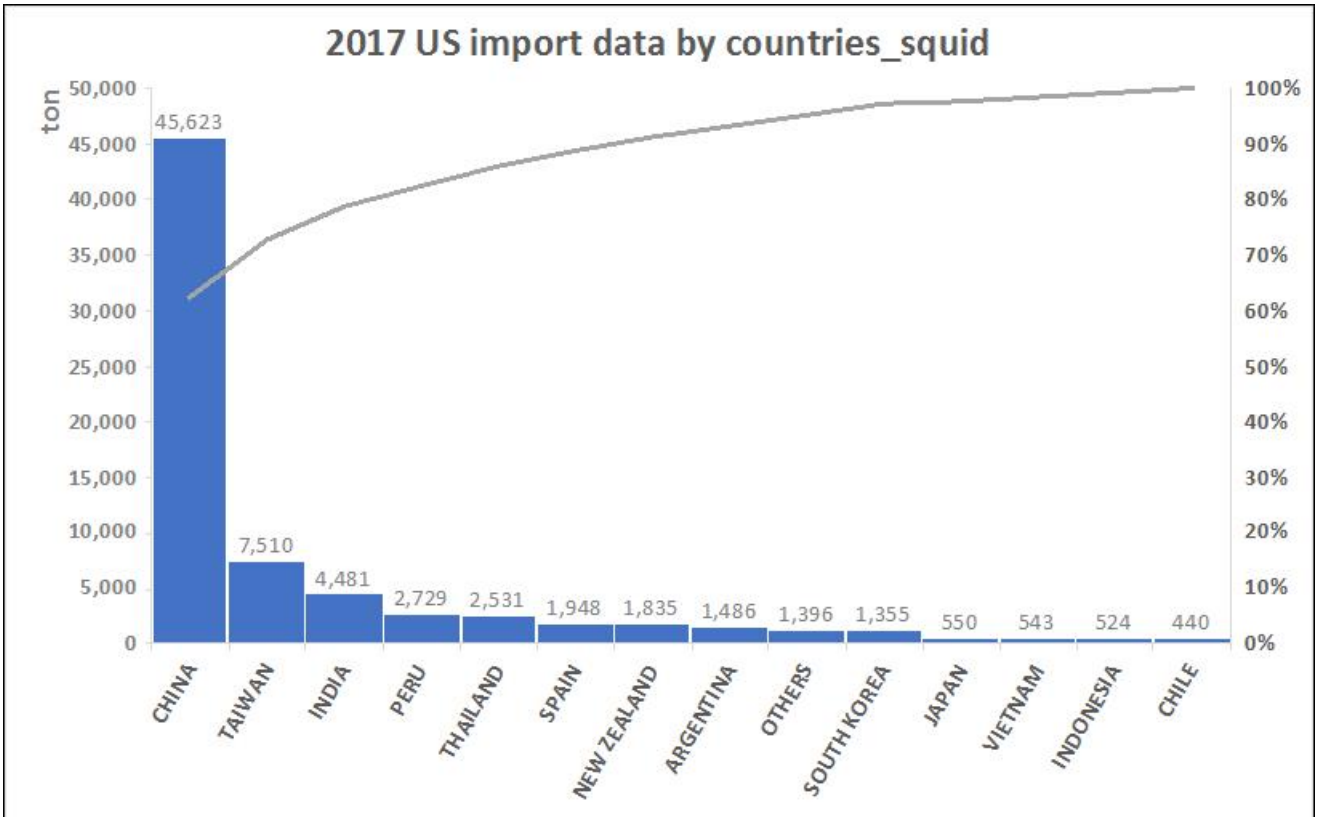

Figure 7: 2017 US squid import volumes (NOAA Office of Science and Technology 2019)

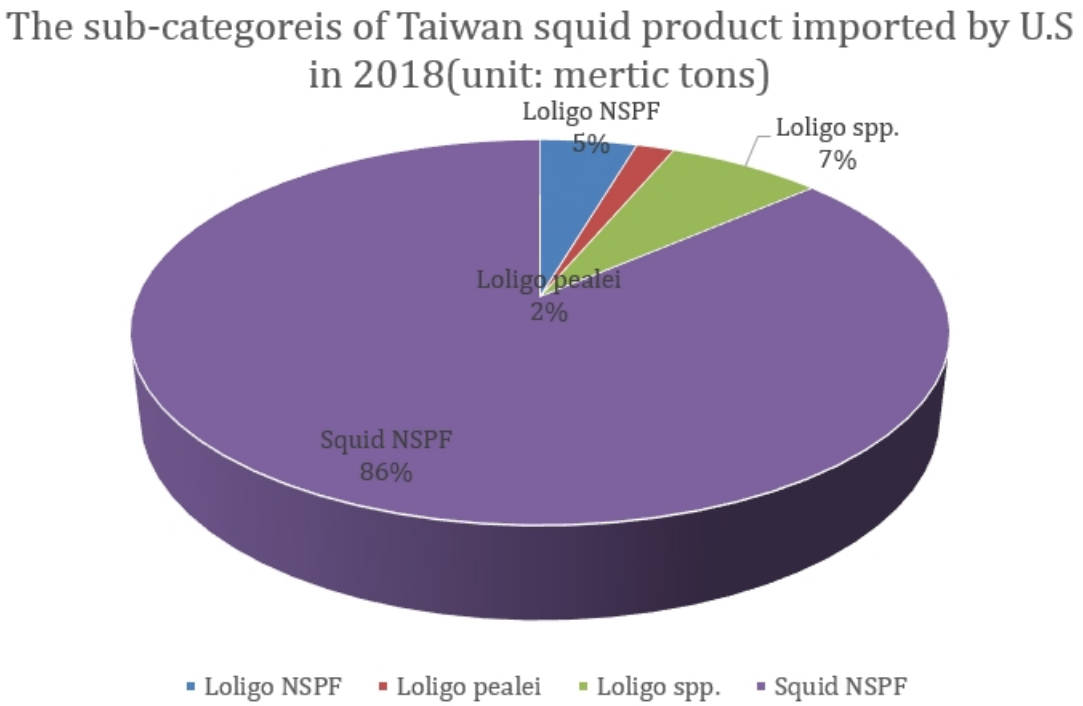

Figure 8: The detailed categories of U.S imported TW Squid products (NOAA Office of Science and Technology 2019)

Common and market names.

Argentine shortfin squid is commonly marketed as 'squid' or 'calamari'. In Mandarin, it is marketing as 'A gen ting you yu'.

Primary product forms

Squid are sold mainly as frozen whole, cleaned(peeled) mantle, rings, and seafood mix forms. Dry and pickle products are popular in Asia.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level*

Criterion 1 Summary

ARGENTINE SHORTFIN SQUID			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Southwest Atlantic | Jig	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance
Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*

- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

Argentine shortfin squid

Factor 1.1 - Abundance

Southwest Atlantic | Jig

Moderate Concern

The quantitative squid stock assessment is lacking and two data-limited stock assessment research suggested the stock was healthy in the past years (Chang, K.-Y. et al. 2016)(Wang Jintao. et al. 2018). On the other hand, the variable and relatively low landing status of illex squid in recent years together with the PSA result showed the high vulnerability of shortfin squid, These facts bring in the uncertainties pertaining to the squid stock status. Based on the above facts, a score of 'moderate concern' is given.

Justification:

The stock abundance of Argentine shortfin squid in the Southwest Atlantic Ocean is unknown as there is currently no comprehensive monitoring of stock status. The Falklands and Argentina are restarting joint survey and stock assessment cover *illex* squid mainly the winter spawning stock. They found the management goal, maintains an escapement more than the reference point was achieved indicated the successful management and potential good stock condition (Winter, A. 2019). However, the research is unable to cover the high sea catches which are presumably significant. There is some research that utilizes squid landing/survey data to estimate regional/specific squid stock biomass via mathematical modeling. All data for stock biomass are more than 5 years old which results in high uncertainty considering the squid's short life span and high stock variation characteristics (Na Li. et al. 2017) {Wang, Jintao. et al. 2018}(Xin-jun Chen. et al. 2008). Due to lack of management, monitoring of fishing effort, and stock survey, the abundance of Argentine shortfin squid in the SWA fishing is difficult to determine.

Other stock relevant data are used to understand the shortfin squid stock performance. IUCN has assessed Argentine shortfin squid a score of 'least concern' but indicated the *I. argentines* is heavily fished and possibly beyond the maximum sustainable level (Barratt, I. et al. 2014). The Productivity-Susceptibility Analysis (PSA) analysis found shortfin squid to be highly vulnerable to jig fishing. However, research on the South Patatgonia (SP) stock biomass estimation, which is the most abundant and main fishing stock for the China and Taiwan fleets, included the Taiwanese fleets inside the Falkland island EEZ, where SPS is the only I. argentines stock to appear in the Falkland Conservation Zones (Arkhipkin A. et al. 2013), concluded the squid yearly biomass from 2000 to 2010 was higher than B_{MSY} and the resource of *I. argentinus* was at a high level. Also, Taiwan researcher used own fishing efforts data from 2003 to 2012 in Southwest Atlantic Ocean to adopted geostatistical techniques and indicated the shortfin squid remains in a healthy status under current fishing level(Chang, K.-Y. et al. 2016). Meanwhile, the Falkland Islands government found the steady recovery of the SP stock from 2011 to 2013 {Wang, Jintao. et al. 2018}. Desktop research cannot locate any high seas squid stock related data from 2013 to 2019 except the fisheries landing data. The FAO squid fisheries landing from 2006 to 2017 for the China and Taiwan fleets all experienced 'increase-decrease-increase' fluctuation, and since 2016 squid harvest has been in dramatic decline and has maintained a relatively low level (Figure 10). Also, the news reported the harvest of Argentine shortfin squid inside the Argentinean EEZ found the reduction of harvest and the harvest is concentrated on small-size individuals in 2019(Harkell, Louis. 2019). The overall 2019 squid harvest in Argentinean EEZ still remains at a low level when compared to the period from 2014 to 2019 (Figure 11) (Harkell, Louis. 2019). The article also summarized the Argentinean regional catch information from 2017-2019 showed the stable of low-level squid harvest similar to 2017 in a relatively low position (Harkell, Louis. et al. 2018)(UndercurrentNews. 2019). The fluctuation of squid harvest volume could be the result of the squid biological characteristics, fishing efforts, and environmental change, or some combination of the three.

Shortfin squid is a short life span species where all adults die following reproduction and each year's recruitment is completely dependent on the previous year's reproductive success. Published studies mention environmental variables having an influence on shortfin squid stock variation while currently no clear understanding regarding how environmental variables and fishing efforts influence on the squid stock variation (Arkhipkin, A. I. et al. 2015)(Hua-jie Lu. et al. 2010)(Na Li. et al. 2017). The environmental changes may have a significant impact on the squid

resource abundance which embodies the variation of harvest volume in the recent year under no high sea fishing management background.

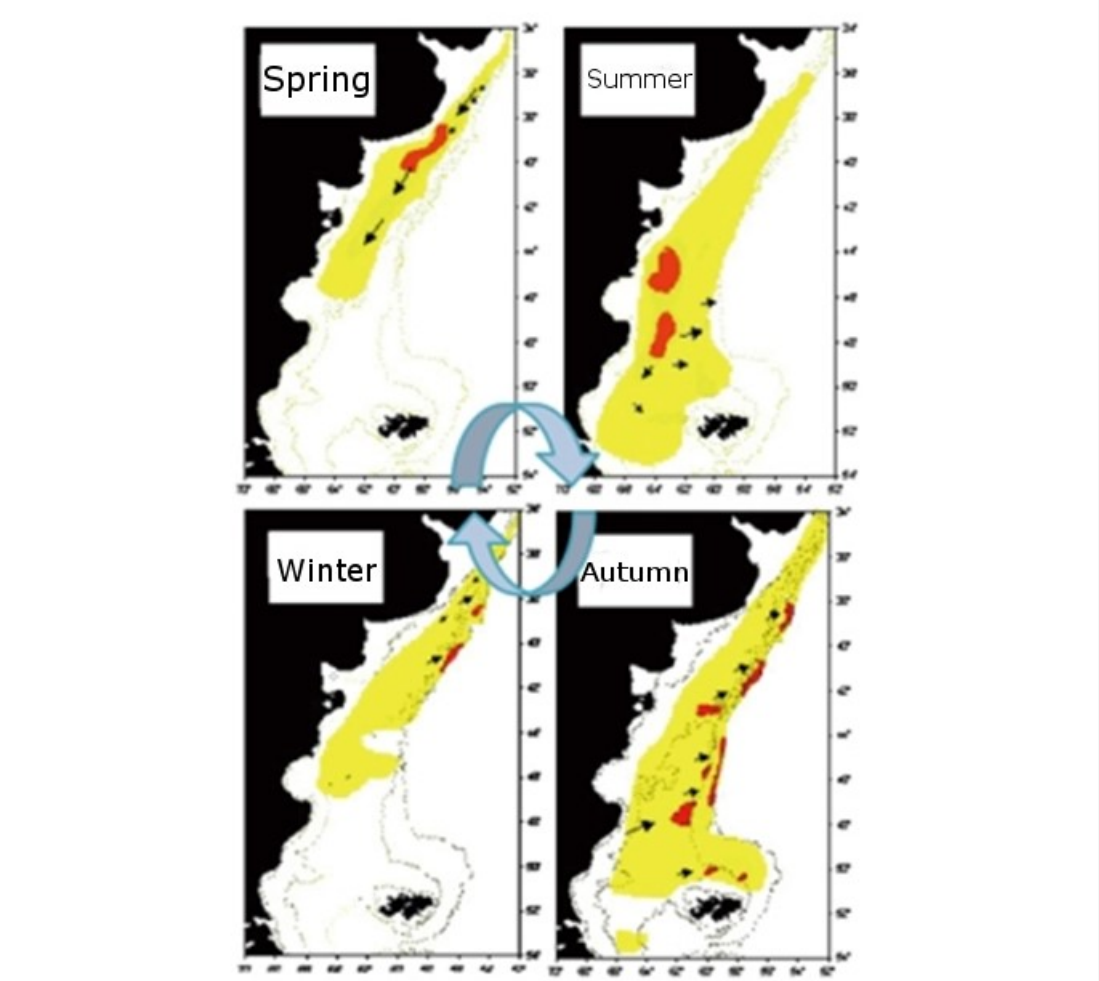

Figure 9: The movement of Argentine shortfin squid fishing ground (red indicates the main fishing ground and yellow indicates the probably distributing areas)(Japan Fisheries Agency 2018a)

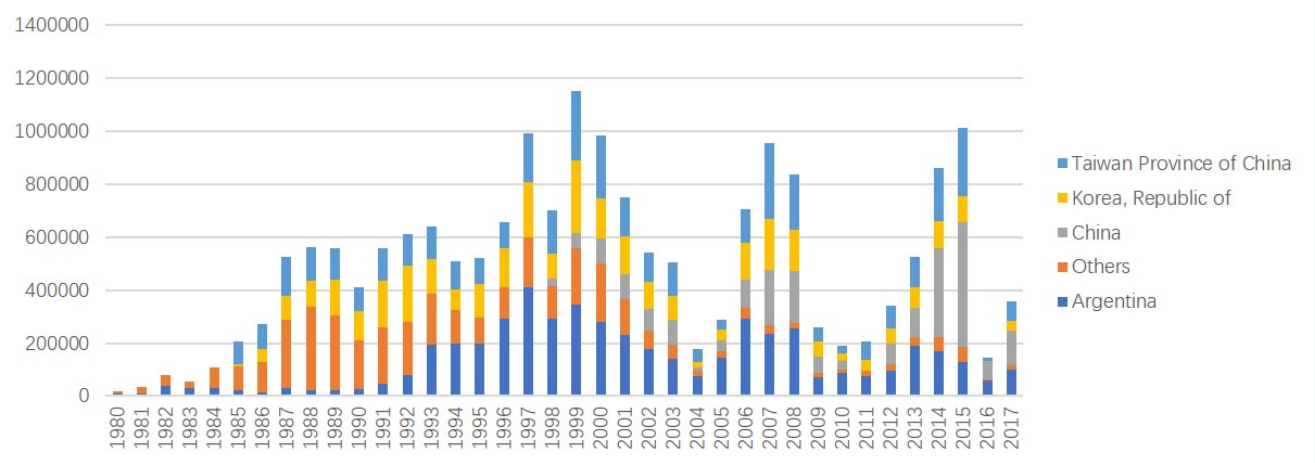

Figure 10: The FAO Argentine shortfin squid harvest volume from 1980-2017 for main exploited countries (Units: MT, Data source: FAO FishstatJ)

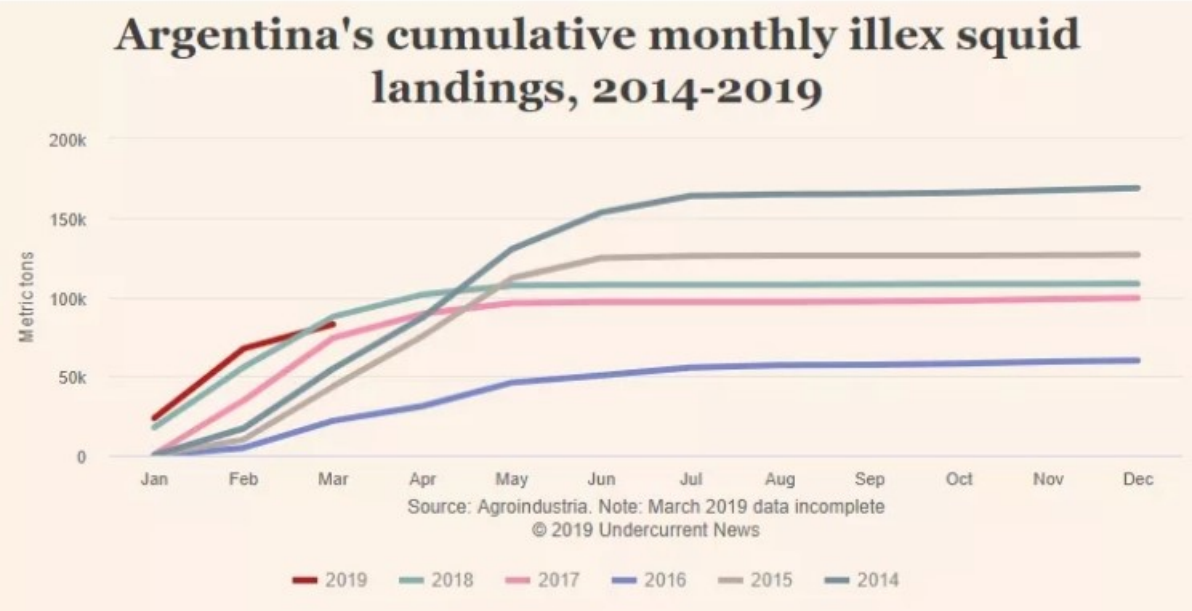

Figure 11: Argentina's cumulative monthly illex squid landing, 2014-2019 (Harkell 2019)

Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) – 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Vulnerability Score Range

- *< 2.64 = Low vulnerability*
- *≥ 2.64 and ≤ 3.18 = Medium vulnerability*
- *> 3.18 = High vulnerability*

For details on the PSA method and scoring, please see the Seafood Watch Criteria

The PSA score for Argentine shortfin squid = 3.35. For this reason, the species is deemed as having a "High Vulnerability." Detailed scoring of each attribute is shown below.

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	<1 year (Barratt, I. et al. 2014)	1
Average maximum age	1 year (Haimovici, M. et al. 1998)	1
Fecundity	750,000 eggs (Laptikhovsky, V.V. et al. 1993)	1
Average maximum size (fish only)	N/A	
Average size at maturity (fish only)	N/A	
Reproductive strategy	Pelagic spawner (Leta, H.R. 1992)	1
Trophic level	3.8 {Bellagia et al. 2014}	3

Density dependence (inverts only)	None	2
Susceptibility Attribute		
Areal overlap (across all fisheries)	High overlap	3
Vertical overlap (across all fisheries)	High overlap	3
Selectivity of fishery (specific to the fishery under assessment)	Most jigging operations use lights to attract squid, which increase their susceptibility (Boyle, P. et al. 2005)	3
Post-capture mortality (specific to the fishery under assessment)	Retained	3

Factor 1.2 - Fishing Mortality

Southwest Atlantic | Jig

Moderate Concern

There are no data on the fishing mortality level in the SWA high seas fishery due to a lack of management and monitoring effort since 2005. The stock biomass data, $B_{MSY,}$ or other fishing monitoring data are absent. The total squid harvest volume in the high seas is unknown but it is believed that Argentina, China, and Taiwan are the main harvesting countries/regions according to the FAO catch statistics. For Taiwan vessels fishing inside the Falkland island EEZ, fishing activities are monitoring while no F_{MSY} is set to manage the fishery probably due to its migratory property. But general fishing efforts management (e.g., stop renew the permit, close the fishery earlier) are in place during the specific season when stock abundance is evaluated as poor. The catch data of above countries/regions can be seen below (Figure 10). From the figure, a fluctuation tendency of squid harvest can be found, and this phenomenon may be connected to variations in squid spawning stock biomass.

One Chinese study utilized the 2000 to 2010 fishing effort data from the Chinese & Taiwan fleets to model the potential annual biomass. It concluded that the fishing mortality at that period was smaller than $F_{0.1}$ and F_{MSY} (Wang Jintao. et al. 2018). Another Taiwanese research claimed the Southwest Atlantic *illex* biomass was estimated more than 2 fold higher than the annual catch, indicating that the squid remains in a healthy status under current fisheries exploitation (Chang, K.-Y. et al. 2016). But both research were only based on regional data that are unable to fully consider the overall exploitation in the Southwest Atlantic and the date were more than 5 years ago. The recent joint stock assessment by Argentina and Falkland on winter spawning stock found the management met 40% escapement reference point, but this is restricted in EEZ waters no include the high seas (Winter, A. 2019).

Overall, considering the unknown fact of the overall fishing mortality, a score of moderate concern is awarded to this criterion.

Justification:

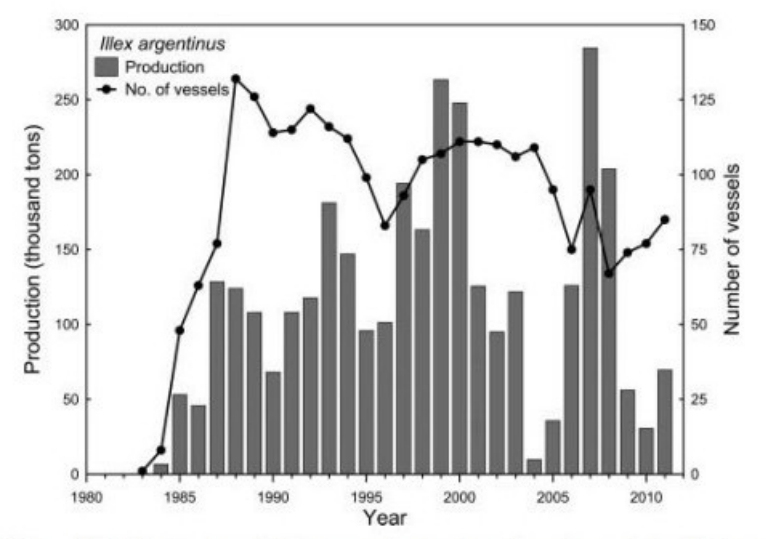

Figure 12: Production of Illex argentines and number of vessels for Taiwanese distant-water squid fishery in the SWA Ocean between 1983 and 2011 (Arkhipkin, A. I., Rodhouse, P. G. K., Pierce, G. J., Sauer, W., Sakai, M., & Allcock, L. 2015)

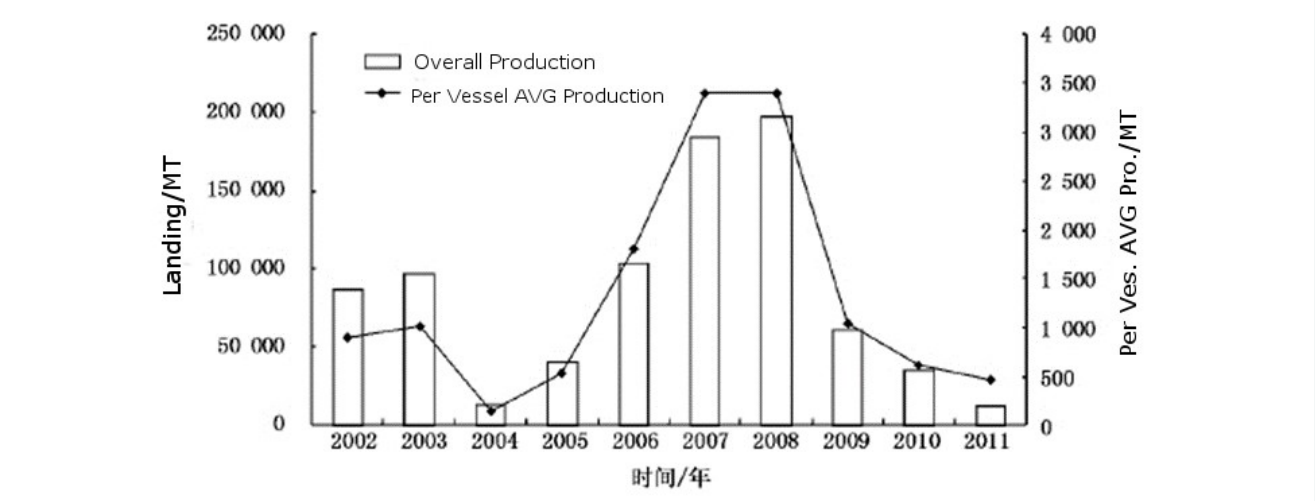

Figure 13: Annual catch of ilex argentines by Chinese mainland in the SWA Ocean during 2002 to 2011 (Chen Xin-jun, Lu Hua-jie, Liu Bi-lin 2012)

The Chinese jigging fishery began targeting shortfin squid in 1997, both in the SWA high seas and later in the Argentinean EEZ. The number of vessels increased and reached a total of 130 in 2013, with an extra 10 vessels fishing inside the Argentinean EEZ under a bilateral agreement ((Long Zhang. et al. 2013). The annual catch is variable for the Chinese fleet which maintains an annual catch level of 35,000~47,000 metric tons from 2006-2016. Taiwan jigging vessels mainly fish on the high seas around 45-46°S and north of the Falkland Islands between December and June. Some fishing vessels operate within the Argentinean EEZ and FICZ under local licenses (Arkhipkin, A. I. et al. 2015). The annual production of *I. aregntinus* by Taiwanese jiggers varied from 12,838 to 284,707 metric tons between 2006 and 2016, and the total number of Taiwan jigging vessels is currently around 70-80 vessels. Shortfin squid's fishing mortality in the SWA high sea has not been monitored since 2005 while harvest data from 2005 to 2016 showed an irregular increase and decrease changes. This phenomenon suggests the squid stock variation is influenced by many factors beyond fishing mortality.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

ARGENTINE SHORTFIN SQUID			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Southwest Atlantic | Jig	2.236	1.000: < 100%	Yellow (2.236)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

SOUTHWEST ATLANTIC | JIG			
SUB SCORE: 2.236	DISCARD RATE: 1.000	**SCORE: 2.236**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Seabirds	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Argentine shortfin squid	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Jigging is widely recognized as a very selective method of catching squid. A review of discards in the world's fisheries conducted for the United Nations Food and Agriculture Program in 2005 found an average discard rate in squid fisheries of 0.2% of the catch, one of the lowest in the study (Kelleher 2005). Data from the Falkland Islands Illex fishery

suggests the jigging fleet is very selective, with little or no bycatch. The study notes that in "the 1990s another ommastrephid squid, *Martialia hyadesi*, was also caught in reasonable quantity (e.g. 5,803 tonnes in 1995), but in recent years there has been little or no *Martialia* caught." (Anonymous 2017) That analysis also indicates no known mortality of seabirds in the fishery. However, little is known about the high seas fishery, and the catch volumes are such that even low discard rates could have some impact on less abundant populations, especially those that are rare or depleted. Few data are available to quantify these impacts. There is some evidence from reports in the early-mid 2000s that the fishery catches seabirds. It appears this is for direct consumption rather than bycatch through normal fishing practices. That study focused on black-browed albatross (*Thalassarche melanophris)*, which at that time was considered 'endangered' by the IUCN, and notes that even if catch per boat is low, the fleet is large enough that it could still have an adverse impact on the albatross population (Huin and Reid 2006). A number of other seabirds appear to overlap with the Argentine shortfin squid fishery area, so seabirds are assessed as a group in this report. No other taxa are further assessed in this report.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality
(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

Seabirds

Factor 2.1 - Abundance

Southwest Atlantic | Jig

High Concern
The black-browed albatross, the focus of the study by (Huin and Reid 2006) noted in the summary above has a wide range with breeding populations in the Falkland Islands and other areas of the South Atlantic. While considered 'Endangered' by the IUCN from 2003-2012, the IUCN status was recently (2017) upgraded to 'Near threatened' (2013-2016) and to 'Least Concern' in the most recent assessments (2017-2018) (iucnredlist.org). A number of other albatrosses and petrel populations overlap with the broad region in which the Argentine shortfin squid fishery operates. Examples based on range maps in {Carneiro et al 2016} are presented below, along with their IUCN status (iucnredlist.org). While many are considered 'Least Concern,' some are considered 'Vulnerable' or 'Endangered.' For this reason, abundance is deemed a 'high concern.'

- Black-browed albatross (*Thalassarche melanophris) - Endangered 2003-2012, improving to Least Concern in 2017-2018.*
- Grey-headed albatross (*Thalassarche chrysostoma) - Endangered 2018*
- Northern giant petrel (*Macronectes halli) - Least Concern 2018*
- Southern giant petrel (*Macronectes giganteus) - Least Concern 2018*
- Wandering albatross (*Diomedea exulans) - Vulnerable 2018*
- White-chinned petrel (*Procellaria aequinoctialis) - Vulnerable 2018*

Factor 2.2 - Fishing Mortality

Southwest Atlantic | Jig

Low Concern
There is no specific seabird bycatch research regarding the assessed fisheries. Published research regarding the seabird mortality analysis conducted by fisheries observation found the incidental mortality associated with jigging is minimal (Wolfaardt, Anton et al. 2010)(Anonymous 2017). Furthermore, jigging is concluded by seabird bycatch researcher as low-risk gear (American Bird Conservancy 2016). A 'low concern' is given here.

Factor 2.3 - Discard Rate/Landings

Southwest Atlantic | Jig

< 100%
There is no bait used in the squid jigging fisheries and other by-catch species, like squids and finfish, only account for tiny percentages based on research findings. Relevant bycatch will probably be retained instead of discarded as is the Asian tradition. There is no other harvest discard in the fishery based on a expert communication (Personal communication,Shanghai Ocean Univerisity (SHOU)).

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

The Criterion 3 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Southwest Atlantic | Jig	Ineffective	Ineffective				**Red (1.000)**

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation
Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy
Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a

Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring
Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations
Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion
Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Southwest Atlantic | Jig

Ineffective
The Southwest Atlantic is the only region of the high seas to not have international management in place. Coordination between the Falkland Islands and Argentina ceased in 2005, and restarted again only in 2019 with a cruise and stock assessment of limited scope (no high seas catch or biomass data were included). Given the size of the fishery, there is an urgent need for more comprehensive coordination to better understand the impacts of the fisheries on squid (and other species) and to then ensure fishing mortality is controlled at a sustainable level. Management by an individual country (e.g. the Falklands, which is likely following squid management best practice) will likely have a minimal impact unless there are coordination and agreement with other countries operating in the high seas fishery. Joint management is critical for long term sustainable squid resource utilization, especially under the background that *illex* squid is a highly variable and straddling species. A score of 'ineffective' is awarded to this criterion.

Justification:
The China and Taiwan squid jigging vessels are mainly operating on the SW Atlantic High seas, only a small number of Chinese vessels are fishing inside the Argentinean EEZ and a few Taiwanese vessels operating inside the FICZ/FIOZ under the fishing license leasing agreement.

In 1990, a bilateral South Atlantic Fisheries Commission (SAFC) was established that included Argentina and the United Kingdom to manage high sea fisheries resources included the *illex.* It applied survey and set catch limit based on the spawning stock biomass to manage the squid while since 2005 the SAFC has been inactive because the Argentine Government reduced cooperation and suspended joint scientific activities. Currently, the Southwest Atlantic high seas region suffers from lack of any effective regional management and conservation of straddling *I. argentinus* stocks because there is no regional fisheries management organization (RFMO)(Arkhipkin, A. I. et al. 2015). China (mainland) and Taiwan are only implementing general fisheries management in the aspect of legal and regulated fishing activities on high seas fishing; there are not any squid specific management measures in place (Ministry of Agriculture and Rural Affairs. 2016)(Taiwan Fishery Agency 2018). Countries with fishing waters in which *I. argentinus* occurs now impose conservation measures separately. For those Taiwanese jiggers fishing within Falkland Island EEZ. Falkland government uses short-term (seasonal) licenses, onboard observer, comprehensive fishing log system and so on to manage the *illex* resources while even it is doing good in all

available management measures, *illex* as a straddling species that means single region's management is not enough able to effectively manage the resources. This situation impairs the Falkland island's management effect and makes *I. argentinus* stock become more vulnerable.

Since 2000, *I. argentinus* abundance also become more variable (Falkland Islands Government, 2012), probably reflecting both climatic variation and overexploitation. *illex* harvest volume statistics from China and Taiwan indicate fluctuation in harvest volume during the past 15 years during which time there has been a lack of management in the fishery (Figure 12 and 13). This phenomenon indicates environmental variables might have a stronger influence on Argentine shortfin squid biomass than human activities. Stock modeling research conducted by Chinese researchers suggested the high seas *I. argentines* SPS stock, from 2000 to 2010, did not undergo overfishing and the fishery was in a good state after considered the environmental conditions of the squid habitat {Wang, Jintao. et al. 2018}. From 2010 to the present the high seas squid management and stock assessment have been absent. The landings from 2010 to 2016 have been fluctuating and in recent years the global harvest volume maintains at a relatively low level indicates possibly low in stock abundance.

The assessed Argentine shortfin squid is a transboundary species found in multiple countries' jurisdictions and the high seas. It requires co-management efforts from all stakeholders as an effective solution to conserve the resources. There are currently lacking cooperation efforts in the Southwest Atlantic Ocean squid management. The previous RFMO, SAFC, was dissolved in 2005 under the disengagement of Argentina. Since that time all the high seas fishing are without any management or regulation in place and all fishing behaviors rely on flag vessels' self-management. Individual countries like Falkland Island conducts a series of management efforts to conserve squid resources inside its EEZ, which such regulations are also applicable to other foreign vessels (For instance, Taiwan flag vessels operating in Falkland EEZ under bilateral agreement) but this is no enough to address the management and stock conservation for migratory *illex* resource.

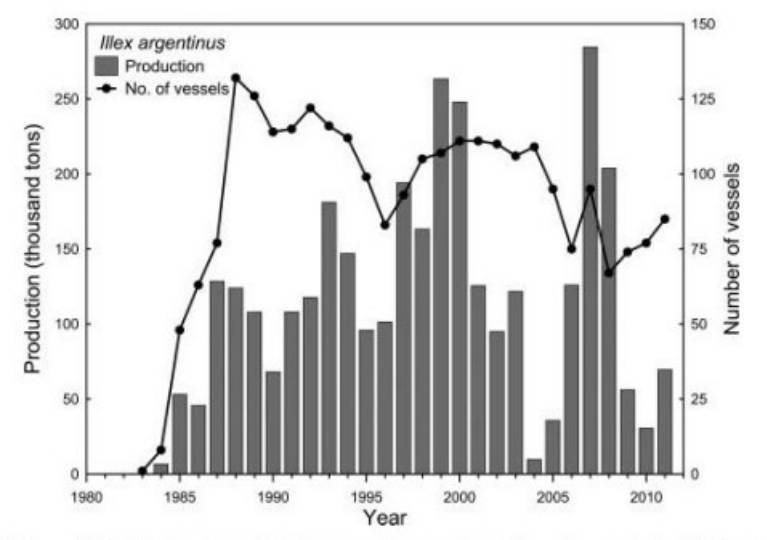

Figure 14: Production of Illex argentines and number of vessels for Taiwanese distant-water squid fishery in the SWA Ocean between 1983 and 2011 (Arkhipkin, A. I., Rodhouse, P. G. K., Pierce, G. J., Sauer, W., Sakai, M., & Allcock, L. 2015)

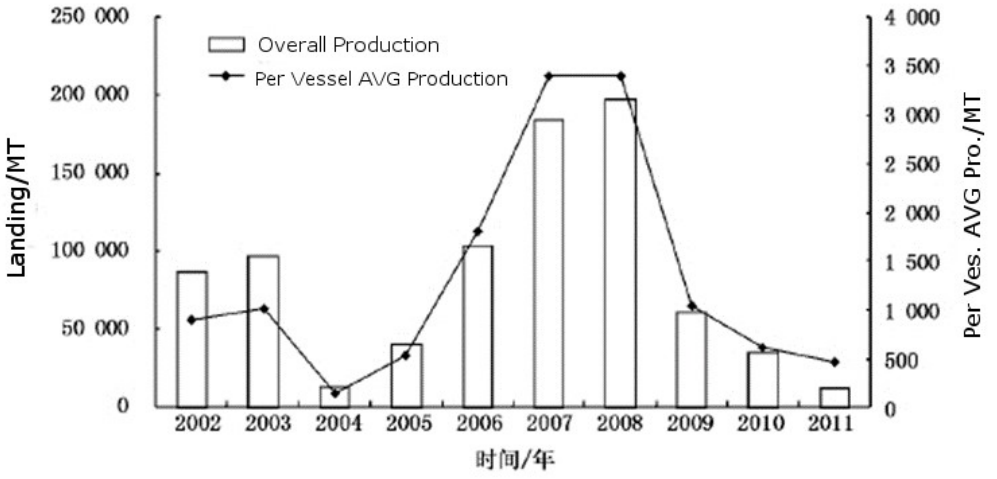

Figure 15: Annual catch of ilex argentines by Chinese mainland in the SWA Ocean during 2002 to 2011 (Chen Xin-jun, Lu Hua-jie, Liu Bi-lin 2012)

Chinese vessels in Southwest Atlantic High seas:

As no regional management body or regulation exists in the SW Atlantic high seas fishing area, the management of Chinese squid jigging vessels are conducted by the Chinese government, Ministry of Agriculture and Rural Affairs, which also cooperates with its subordinate civilization society, China Overseas Fisheries Association (COFA). The management is limited to meet the Chinese high seas regulations and the United Nations Convention on the Law of the Sea. Current management is limit to the legal operation, timely fishing log record, and vessel update report. Management in areas of stock or resource conservation is lacking.

Some publications reported IUU behaviors of Chinese squid jigging vessels in the Southwest Atlantic high seas, including occasionally entering the Argentinean EEZ illegally {Fu, Xiao-yin. 2016}, switching off the AIS devices-typically at night in order to fish undetected(Harkell 2018b). These IUU cases indicating the ineffective of squid vessels management in the Southwest Atlantic high seas. The Chinese government mentioned it is actively engaging in high seas IUU behavior combating (Ministry of Agriculture and Rural Affairs 2018) and published regular punishment report recorded those high seas IUU cases be found but still the IUU activities by Chinese vessels in the high seas are continuing.

Taiwan vessels in Southwest Atlantic High seas:

Taiwan (TW) vessels operating in the Southwest Atlantic high seas also completely rely on self-management. The TW Fisheries Agency is the leading authority on regulating/managing Taiwan high seas vessels, including regulates on-sea transshipment, issue Permit and conduct annual vessel review, track VMS and vessel report, guarantee legal fishing behaviors {Fishery Agency 2018}. However, there is no specific management on the squid resources conservation/utilization. Furthermore, the effectiveness of general high seas fishing_regulation/management is unknown while the fact that many reports mentioned the TW high seas squid vessels conducted illegal invade and other IUU behaviors were found on literature review.

Taiwan vessels in the Falkland Islands Conservation Zone/Falklands Outer Conservation Zone (FICZ/FOCZ):

Taiwan jig vessel fishing inside the Falkland EEZ (FICZ/FOCZ) through license buying system to obtain fishing right while The Taiwanese vessels only stay certain period (from March to May) inside then will move out to the high sea to track the squid migration (Stanley 2017). The Falkland government set management regulations to all these vessels, require harvest report, by-catch mitigation, observer monitoring to collect accurate fishing data and avoid illegal behaviors on board beyond the self-managements that Taiwan vessels have (Stanley 2019).

The Taiwanese vessels are general following all regulations and maintain long-term fishing access relationship with Falkland island. The management measures implemented by Falkland to *illex* are only general input control

measures and short of specific management measures compare to other squid resources, like Patagonian squid (*loligo gahi*), may due to the sharing property of *illex* compare to *loligo (Aguilera, S. E. 2018)*. Without cooperation management currently in the Southwest Atlantic Ocean is weaken the single management unit's effort inside the Falkland island EEZ and gives more uncertainties for the *illex* resources utilization in the long-term.

Factor 3.2 - Bycatch Strategy

Southwest Atlantic | Jig

Ineffective
The assessed fisheries on the SWA high seas lack management or regulation for minimizing or mitigating bycatch impacts. However, the jigging fishery is a highly selective fishing method with bycatch usually less than 5% of the total catch. There are some data reported that identify the capture of seabirds (Huin and Reid 2006). There are regulations inside TW high seas fisheries acts that require the release of accidental/intentional harvested shark and prohibit the shark finning in the jig fishery {Fishery Agency 2018}. Similar regulations are placed by the Chinese government to high sea vessels in order to conserve ETP species (MoAnRA 2019). However, occasional case reports indicated potential ETP bycatch has happened. There is a case released by China MoARA in 2018/02 that refers to a Chinese transport vessel that was operating for transhipping SWA squid catch being found with undocumented tuna and shark onboard (including the ETP species hammerhead shark)., suggesting illegal transshipment while MoARA did not disclose where the IUU harvest comes from and it may from same areas that squid be fished (Ministry of Agriculture and Rural Affairs. 2018). Because there is no bycatch management/monitoring in place for the high seas *illex* fishing and there is no knowledge in the bycatch degree of ETP species, a score of 'ineffective' is awarded to this factor.

The fishery department has a good range of skilled staff with a well-established observer programme. Meanwhile squid jigging is a highly selective fishing method. Based on the research understanding, there is no fish and sharks by-catch in recent years. There is no fishing mortality associated with the jig fishery for the seabird interactions based on government management records also a series of seabird bycatch mitigation measures are required to implement and data showed under high compliance level (Anonymous 2017)(Falkland Government 2019). No data regarding by-catch of other species (Anonymous 2017). Due to the highly selective fishing method and precautionary measures in place to minimize potential by-catch risk, a score of 'highly effective' is awarded to the Falkland Islands bycatch management.

In overall, even Falkland Islands' bycatch management is highly effective, while no management/monitoring in SWA high seas where *illex* as a straddling resource received more heavily fishing. An score of 'ineffective' is given to this criterion.
Justification:
In contrast to bottom trawls and purse seines, squid jigging is inherently a selective method that seldom produces bycatch of other species including ETP species. There are some bycatch species be reported in the SWA *illex* jigging operation, including bycatch of other squid species (Anonymous 2017), together with anecdotal evidence for bycatch of albatrosses (Huin and Reid 2006). In general, jigging gear is highly selective that able to minimize the bycatch concerns but relevant management and monitoring are necessary to better address the potential risks.

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Southwest Atlantic | Jig	5	0	High Concern	**Yellow (3.162)**

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

Southwest Atlantic | Jig

5
The assessed fishery using jig gear to fish shortfin squid in the middle or surface of sea via light attraction, and the applied gear does not contact the sea bottom. This kind of fishing method has very limited influence on the benthic ecosystem and a score of 5 is given following the SFW standard.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Southwest Atlantic | Jig

0
Following the SFW standard, the assessed fisheries are obtained a score 5 in factor 4.1 then factor 4.1b can be skipped automatically. Also, there is no need to modify gear for mitigate the fishing impact to the seafloor habitats because such contact is not existing.

Factor 4.3 - Ecosystem-based Fisheries Management

Southwest Atlantic | Jig

High Concern
I. argentines, this forage species has been found play a keystone role in the southern Atlantic ecosystems (Dunne, Santiago. 2017)(Haimovici, M. et al. 1998). It is the important prey of large pelagic and demersal fishes, toothed whales and subantarctic fur seals, also has a clear interaction with *M. hubbsi*, as the important prey for common hake on the Patagonian shelf that providing more than 50% of annual food intake. Argentine shortfin squid also consumed by hoki, red cod, dogfish, and various species of penguin, albatross, some petrels and several seals and dolphins. In general, *I. argentines* is an important prey for many other species in the region which acts as the one of an important link in the food web of the southern Patagonian shelf.

On the other side, *I. argentines* is opportunistic predator feeding on fishes, crustaceans, and cephalopods including smaller conspecifics (cannibalism). Overall, crustaceans (euphausiids and pelagic amphipods) are the main prey.

I. argentines acts as a 'biological pump' integrating different ecosystems at a macro-scale level through the transferal of substantial biomass and nutrients, which is also an essential component of the ocean's homeostasis mechanism. The change of squid biomass via human activities or climate change will influence these trophic links, especially for species like Argentine hake (*M. hubbsi)* which highly preys on the shortfin squid (Dunne, Santiago. 2017).

Unfortunately, there is no management, monitoring, and survey for the SWA high seas squid resources currently. Therefore, associated ecosystem-based management is also missing. For management inside the Falkland island EEZ, management is unable to achieve eco-system-based management yet. Relevant *illex* ecosystem study only remains on understanding what the squid role is in the functioning ecosystem without demonstrating how fishing influences the overall ecosystem. There is no finding on detrimental food web impacts that connect to the assessed squid fisheries base on desktop research. The continual harvest volume fluctuation in the past decades indirectly indicate the squid stock is highly resilient. This resilient biomass feature may prevent harmful change happens in the associated ecosystem.

The important ecological roles of Argentine shortfin squid in the SWA ecosystem are recognized via many studies. While there is non-existent of ecosystem-based management for the assessed fisheries, also no detrimental food web impact caused by the assessed fisheries is located base on the assessment research, a score of 'high concern' is awarded at here.

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Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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