Monterey Bay Aquarium Seafood Watch®

Squid, Jumbo

Jumbo Squid (*Dosidicus gigas)*

Southeast Pacific (Chile, China, Peru)

Jig

11/5/18

Seafood Watch Consulting Researcher

Seafood Watch Standard used in this assessment: Standard for Fisheries vF3

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: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

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

Avoid/Red Take a pass on these for now. These items are overfished or caught 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 recommendations for the South American stock of Humboldt squid (*Dosidicus gigas*). The analysis includes the Chilean and Peruvian fisheries as well as the Chinese fishery for Humboldt squid in the high seas off the Chilean and Peruvian exclusive economic zones (EEZs). In Chile, the majority of the stock is reserved for artisanal fishermen, and jigging (with or without lights) remains the primary method in most regions. In Peru, the stock is almost exclusively exploited by artisanal light jiggers. In international waters outside of Chilean and Peruvian EEZs, the Chinese fishery uses mostly hand jigging, and larger vessels with mechanized jiggers operate a few months out of the year.

Dosidicus gigas has low inherent vulnerability, but its abundance is highly variable and appears linked to environmental conditions. Inside Chilean and Peruvian EEZs, the stock is not considered depleted and fishing effort in Chile and Peru does not exceed recommended levels. A recent stock assessment on Humboldt squid outside these EEZs showed no evidence of overfishing. However, no catch limits for the Chinese fishery have been reported.

Though discard rates and bycatch information for the fishery are not available, jigging with or without lights, the most common gear type used in the Chilean and Peruvian artisanal fisheries and the Chinese industrial fishery, is highly selective for squid. Less selective gears, including trawling, contribute negligibly to US imports.

Management of the stock is moderately effective, but both Chile and Peru lack biological control points and accurate biomass predictions. Chile lacks explicit limits on license-holders and quantitative population assessment, while Peru has more direct and regular methods of biomass evaluation. The Chinese effect on stock is loosely monitored.

Scientific advice is largely followed in Chile and Peru, and enforcement has been effective, although Chilean in-person monitoring of the artisanal fishery is limited. China produces scientific research on *D. gigas*, historically focusing on squid biology and recently providing the initial framework for management of the fishery. As of this report though, the fishery is too recent to have a clear track record, and there is no evidence that enforcement is occurring on the Chinese fleet, a particular problem on the high seas. Artisanal fishers have official recognition in both Chile and Peru, but they are not yet fully included in management decisions.

Jigging has minimal impact on marine ecosystems, though the ecological role of *D. gigas* and the potential effects of its depletion are poorly understood.

Al three fisheries are ranked as a "Good Alternative."

Final Seafood Recommendations

SPECIES/FISHERY	CRITERION 1: IMPACTS ON THE SPECIES	CRITERION 2: IMPACTS ON OTHER SPECIES	CRITERION 3: MANAGEMENT EFFECTIVENESS	CRITERION 4: HABITAT AND ECOSYSTEM	OVERALL RECOMMENDATION
Jumbo squid Chile Southeast Pacific, Jig, Chile	Yellow (2.644)	Green (5.000)	Yellow (3.000)	Green (3.873)	**Good Alternative (3.520)**
Jumbo squid Peru Southeast Pacific, Jig, Peru	Yellow (2.640)	Green (5.000)	Yellow (3.000)	Green (3.870)	**Good Alternative (3.518)**
Jumbo squid Southeast Pacific, Jig, China	Yellow (2.644)	Green (5.000)	Red (2.000)	Green (3.873)	**Good Alternative (3.181)**

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 South American stock of Humboldt squid (*Dosidicus gigas*), a major commercially imported squid species in the United States. The analysis includes the Chilean and Peruvian fisheries as well as the Chinese fishery for Humboldt squid outside Chilean and Peruvian exclusive economic zones (EEZs). In Chile, the majority of the stock is reserved for artisanal fishermen, where jigging (with or without lights) is the primary method in most regions. In Peru, the stock is almost exclusively exploited by artisanal light jiggers. The Chinese fishery operates small vessels with hand jiggers year round and brings in large vessels equipped with mechanized jiggers a few months during the year (Li et al. 2016).

Species Overview

Dosidicus gigas is an ommastrephid squid, subfamily Ommastrephinae. The species is restricted to the Eastern Pacific, historically ranging between subtropical North and South America with temporary excursions to the north and south (Nigmatullin et al. 2001). In the past few decades, it has also become a common presence off the coast of southern Chile and the west coast of the United States, extending as far north as Alaska (Keyl et al. 2008) (Zeidberg and Robison 2007). The species is capable of traveling ~30 km/day and undergoes daily vertical migrations, spending days below 250 m and ascending nearly to the surface at dusk, while diving periodically below 300 m (Gilly et al. 2006) (Stewart et al. 2012).

As with other ommastrephids, *D. gigas* has a lifespan of 1 to 2 years (Argüelles et al. 2001). Rapidly reaching mantle lengths of 1.2 m and weights of 50 kg, it is the largest nektonic squid, though individuals are variable in size (Nigmatullin et al. 2001). The species is semelparous and highly fertile, with year-round reproduction typically producing two cohorts a year (autumn/winter and spring/summer hatchings) (Argüelles et al. 2001), but little else is known about its reproductive biology. Environmental conditions appear to have a large influence on recruitment (Rodhouse 2001).

D. gigas feeds on a wide variety of small pelagic and demersal fishes, crustaceans, and squids, in some cases also targeting larger, economically important species such as hake (Alarcón-Muñoz et al. 2008) (Field et al. 2007) (Markaida and Sosa-Nishizaki 2003). Primary predators are tuna, billfish, sharks, pinnipeds, and toothed whales (Nigmatullin et al. 2001) (Field et al. 2007). Cannibalism is widely observed but likely overreported (Ibáñez et al. 2008).

Globally, *D. gigas* constitutes the world's largest invertebrate fishery (FAO 2014) (Rosa et al. 2013), supporting major fisheries off the coast of Chile and Peru and in the Gulf of California, an occasional fishery off the Costa Rica dome, and a sport fishery on the west coast of the United States. The North and South American stocks constitute genetically distinct subpopulations (Sandoval-Castellanos et al. 2007) (Staaf et al. 2010). Squid caught in Peruvian and Chilean waters are not genetically differentiable (Ibáñez et al. 2011).

Chilean management:

As of 2014, Chile was the world's 11th largest fishing nation (FAO 2016). Fisheries are under the aegis of the Ley General de Pesca y Acuicultura, adopted in 1989 and most recently updated in 2013 (Subpesca 2014d). The executive policy-making branch of Chilean fisheries governance is Subpesca, under the Ministry of Economy, Development and Reconstruction, which incorporates national, zonal, and regional fisheries councils. The separate Sernapesca acts as a control and enforcement body. The Instituto de Fomento Pesquero (IFOP) is a nonprofit corporation, founded both by the Ministry and by the private sector organization Sonapesca, which provides fisheries analysis. The Fondo de Investigación Pesquero (FIP), under the umbrella of Subpesca, also funds fisheries research.

Chilean fishery managers make use of quotas (global, individual, and, in some cases, individual transferable), gear restrictions, seasonal/area closures, establishment of bycatch limits, and size limitations. Regular stock assessments are conducted and management measures set in place by Subpesca according to recommendations made by IFOP and the regional scientific committees. Artisanal fishers have formal recognition: all are officially registered by Sernapesca, are apportioned separate quotas, and have exclusive access to the five miles adjacent to the coastline. Chile is a signatory to most major international treaties and a member of the South Pacific Regional Fisheries Management Organisation (SPRFMO) (FAO 2010b) (OECD 2009).

Recent overexploitation in multiple fisheries and weak monitoring of bycatch, discards, and unreported fishing (OECD 2009) (Perez 2005) is beginning to be addressed by stricter scientific monitoring, as required by Ley 20.625. Vessel monitoring systems are currently mandatory on all large scale fishing vessels (FAO 2010b) (FAO 2010b).

Peruvian management:

As of 2014, Peru was the world's 6th largest fishing nation (FAO, 2016). Fisheries are governed by the General Law on Fisheries (Decreto No. 25977) and managed by the office of the Deputy Minister of Fisheries, a branch of the Ministry of Production (PRODUCE). The Minister is responsible for developing and managing national fisheries policies, and oversees the Instituto del Mar del Perú (IMARPE), which conducts fisheries research, and the Fondo Nacional de Desarrollo Pesquero (FONDEPES), responsible for developing artisanal fisheries (FAO 2010a).

Peruvian fishery managers make use of seasonal/area closures, reductions in the permitted fishing fleet, size limitations, gear restrictions, and establishment of bycatch limits. Regular stock assessments are conducted and management measures set in place by the Minister according to recommendations made by IMARPE and its regional branches. IMARPE has a well-established onboard observer program to monitor discards and bycatch (PRODUCE 2012a). Peru is a signatory to most major treaties and a member of the SPRFMO.

Chinese management:

As of 2014, China was the world’s largest fishing nation (FAO 2016) and, as of 2012, it operated the largest distant-water fleet in the world (Mallory 2013). Historically, management of Chinese distant-water fisheries has been largely nonexistent, but recent documentation and proposed regulation of these fisheries have developed, although such agreements still lack transparency (Blomeyer et al 2012). Previously 100% controlled by the government, China’s distant-water fisheries are now at least 70% owned by private enterprises, thus adding to the secrecy of operations and management (Mallory 2012). However, Shanghai Ocean University maintains an active research program that investigates *D. gigas* biology, with research spanning across habitat, stock assessment, and life history (age, growth, population, reproduction, and feeding ecology) of the species. China remains an active member of many international RFMOs, including the SPRFMO, which is starting to improve the accountability of China’s distant water fisheries.

Regulation of this fishery appears to be in its nascent stages. Based on the 2016 meeting of the SPRFMO’s Scientific Committee (SC), data regarding catch, effort, and *D. gigas* biology are to be reported to the SPRFMO SC Secretariat (Arguelles et al. 2016). Infrastructure for making these reports exists, and a more regular observer program has been recommended for the fishery to accompany China’s sporadic data collection in years 2001, 2007 to 2009, 2013 to 2014 (Arguelles et al. 2016) (Li et al. 2016). Catch statistics, vessel numbers, and CPUE have been recorded from 2001 to 2015 by the China Distant Water Fisheries Association and Shanghai Ocean University and by the National Data Center for Distant-water Fisheries of China since then (Li et al. 2016). Although the stock recently exhibited no evidence of being overfished (Xu et al. 2016) (Xu et al.

2017), there does not appear to be any annual or seasonal quota on the *D. gigas* fishery outside Chilean and Peruvian EEZs.

Production Statistics

Dosidicus gigas capture has expanded dramatically in recent years, due both to increased fishing effort and to the species' population growth and range expansion, potentially tied to climate change and/or the decline of finfish competitors (Gilly et al. 2013) (Keyl et al. 2008) (Zeidberg and Robison 2007). Based on catch data from the FAO's FishStatJ, the recent catch primarily derives from Peru, China, and Chile, with negligible captures by other nations.

Fishery in Chilean waters:

Humboldt squid have been caught incidentally off the Chilean coast since at least 1957, and were caught sporadically at low levels until the 1990s (Rocha and Vega, 2003). The Chilean artisanal jig fishery was initially centered in Coquimbo (Region IV), beginning in the late 1990s or early 2000s (Cortés 2012) (pers. comm., Patricio Galvez, IFOP 2018), and slowly expanded into Regions V and VIII after the 2002 spike in squid landings (Keyl et al. 2008) (Subpesca, 2012a). Primary fishing grounds are nearshore between 36° to 38.5°S and 29° to 34°S. Japanese, Korean, and Chinese vessels also operate in international waters off the Chilean coast (Arkhipkin et al. 2015).

Purse seining remains popular in the Region VIII artisanal fishery, but is likely a minor contributor (Arancibia et al. 2007) (pers. comm., Patricio Galvez) (pers comm., Pablo Lizana 2018) (pers. comm., SeaTec 2018). Artisanal fishers also conducted trawls until gear used in the fishery was regulated in 2013 (pers. comm., Liesbeth van der Meer 2018).

While industrial hake trawlers had opportunistically pursued squid in the past, the directed industrial trawl fishery began in 2011, with the first global quota established in 2012 (Subpesca 2012a). These efforts are primarily focused in the south (Regions VIII-XII), and constitute midwater trawls conducted in short trips with low storage volumes (pers. comm., Patricio Galvez 2018) (pers comm., Pablo Lizana 2018).

Currently (for the period 2014 to 2019), 80% of the global quota is reserved for the artisanal fleet (Subpesca 2013a, 2014b). According to landings by sector reported to Sernapesca in previous years, artisanal catch comprised over 80% of the total for every year since 2001 except 2007 (when artisanal catch constituted 67% of the total) and 2010 (33% of total) (Subpesca 2012a) (Sernapesca 2014).

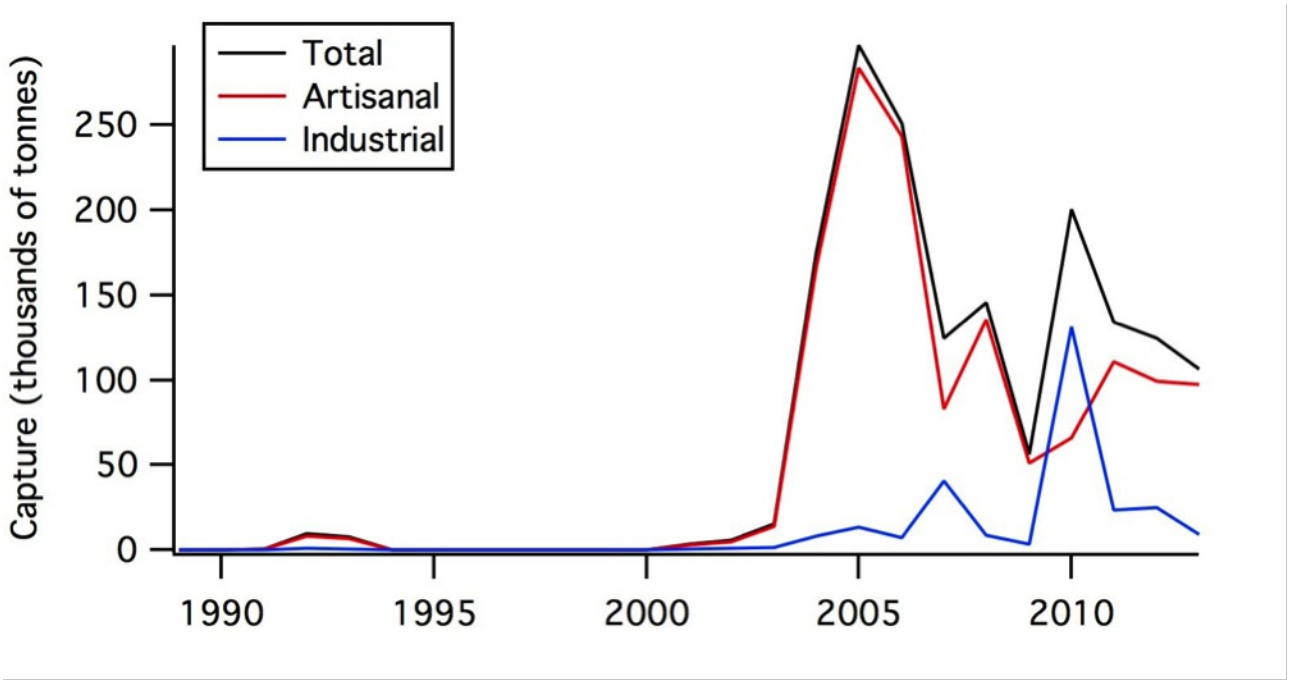

Figure 1 Humboldt squid capture in Chile by sector (Subpesca 2012a) (Sernapesca 2014).

Fishery in Peruvian waters:

USSR trawlers reported Humboldt squid as bycatch off the coast of Peru in the late 1980s, but the species was of low economic importance until the industrial fishery, comprised of Japanese and Korean mechanized jigging fleets, began in 1991 (IMARPE 1996). Japanese and Korean ships have since operated continuously in the Peruvian EEZ from 3 to 7°S (Waluda et al. 2006), with the exception of 1996 (Mariátegui et al. 1997). Japanese, Korean, and Chinese vessels also operate in international waters off the Peruvian coast (Arkhipkin et al. 2015). Catches by the Peruvian artisanal fleet, active primarily in the southern half of the country, were not significant before 1996 (Estrella Arellano and Swartzman 2010). The number of artisanal jigging vessels has increased since 1998, exceeding 4000 in 1998, while the number of participating industrial vessels has concurrently decreased. The artisanal fleet has taken approximately 90% of the catch from 2004 to 2012 (Arkhipkin et al. 2015).

While the IMARPE webpage on Humboldt squid describes the artisanal fishery as using both gill nets and handline jigging (IMARPE 2008), Estrella Arellano and Swartzman found that 97% of catches from 1996 to 2006 came from jigging with lights (Estrella Arellano and Swartzman 2010).

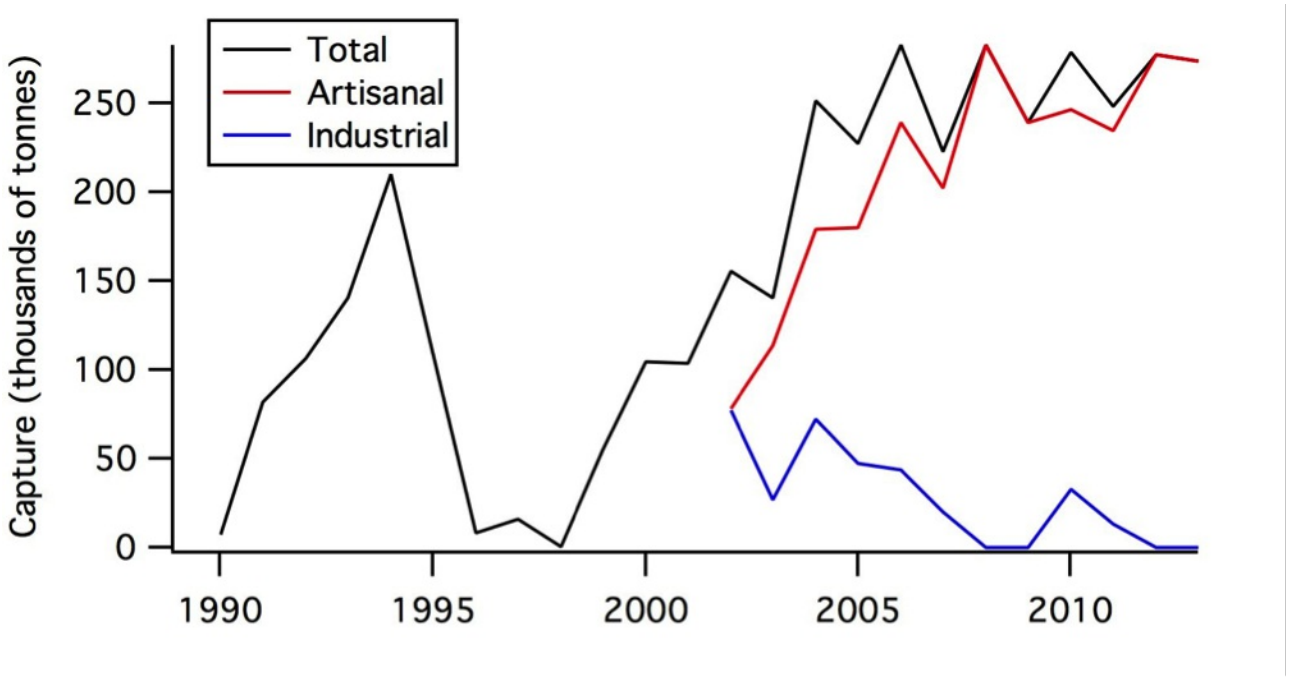

Figure 2 Humboldt squid capture in Peru by sector (sector-specific fishing data unavailable prior to 2002) (IMARPE 1995, 2001, 2005, 2009, 2010, 2013)

Chinese fishery outside Chilean and Peruvian waters:

Most prominently, the Chinese distant-water mechanized jigging fleet, redistributing after declines in *Illex argentinus* stock, has been operating outside the Chilean and Peruvian EEZs from 7 to 20°S since 2001 (Chen et al. 2008). From 2005 to 2010, the Chinese catch stayed below 142,000 tonnes, increased to 250,000 to 264,000 tonnes in 2011 to 2013, and peaking at 325,000 tonnes in 2014 before falling slightly to 323,600 tonnes in 2015 (Arkhipkin et al. 2015) (Li et al. 2016).

Other:

A number of other nations exploit South American *D. gigas* stock. Japanese and Korean fleets are permitted to fish within Peruvian waters. Taiwan has also operated a smaller high-seas mechanized jigging fleet in the southeast Pacific since 2002 (SPRFMO 2013a), with an average annual catch around 21,000 tonnes (Arkhipkin et al. 2015). Ecuador's official *D. gigas* fishery was authorized in 2014, allowing for 30 artisanal and 6 industrial vessels (Subsecretario de Recursos Pesqueros 2014) in coastal waters (Morales-Bojórquez and Pacheco-Bedoya 2016) and off EEZ waters (Liu et al. 2017).

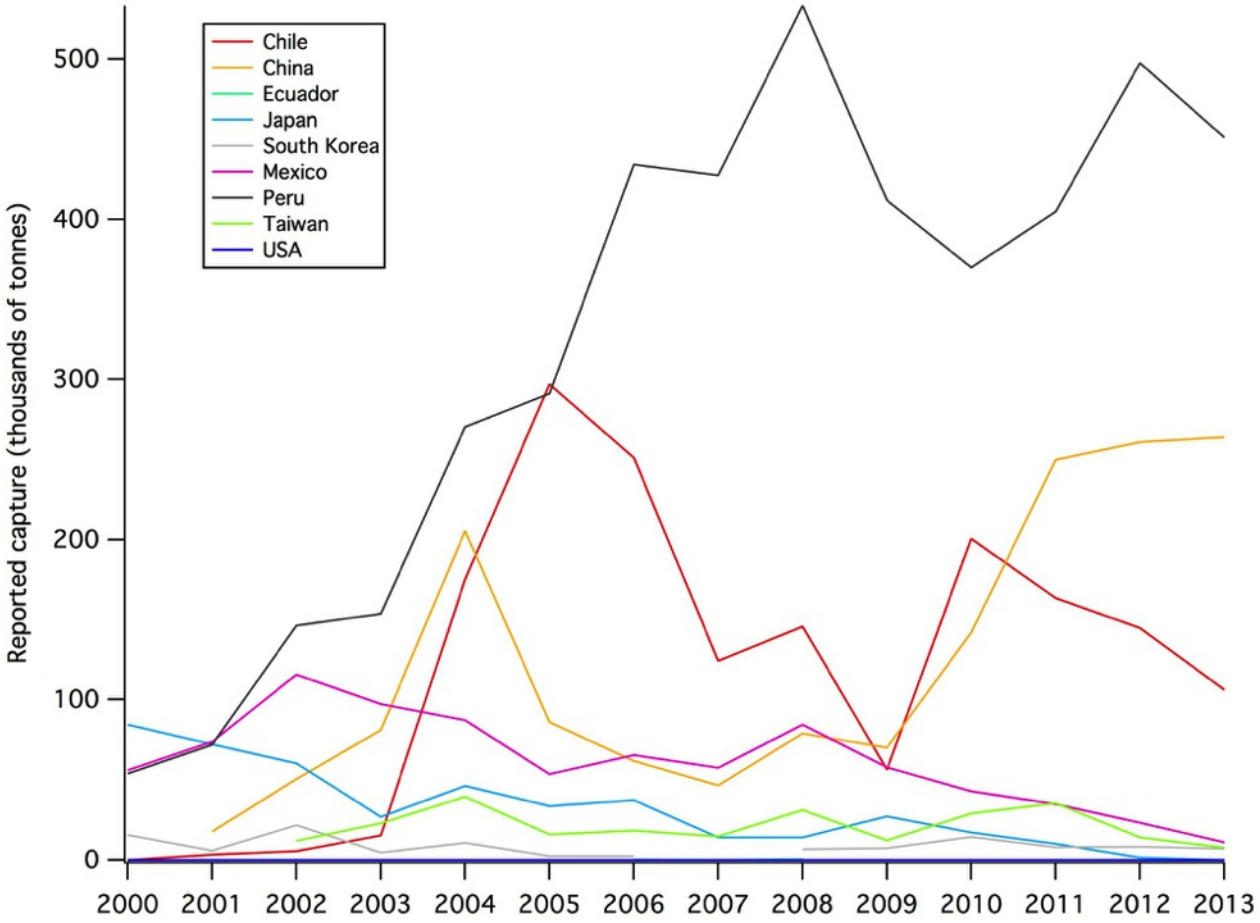

Figure 3 Humboldt squid capture in the South and Central Eastern Pacific by fishing nation (FAO 2014b).

Importance to the US/North American market.

Complete data on Humboldt squid imports into the US are not available: the National Marine Fisheries Service (NMFS) identifies commercial US squid imports as either "Loligo NSPF" or "squid NSPF," where NSPF stands for "not specifically provided for."

According to NMFS data, "squid NSPF" imports are overwhelmingly Chinese in origin. China's fishing statistics are, however, complicated by historical under-reporting of catches in its distant-water fleet (Pauly et al., 2013) and the failure to distinguish *D. gigas* captures from often-significant catches of other squids. Chinese trade statistics are similarly complicated by the importation, processing, and re-exports of other squid species (see Seafood Watch report on California market squid).

According to Chilean customs statistics, approximately 80% of Humboldt squid exported from Chile in 2013 was shipped by SeaTec. Owner Pablo Lizana states that SeaTec exclusively buys from artisanal suppliers because industrially trawled squid are of lower quality (pers. comm., Pablo Lizana, SeaTec Chile 2018); see Chilean customs data provided by Lizana under his name in bibliography). Damage to squid skin and mantle during trawls generally leads to reduced value for trawled catches (Arkhipkin et al. 2015).

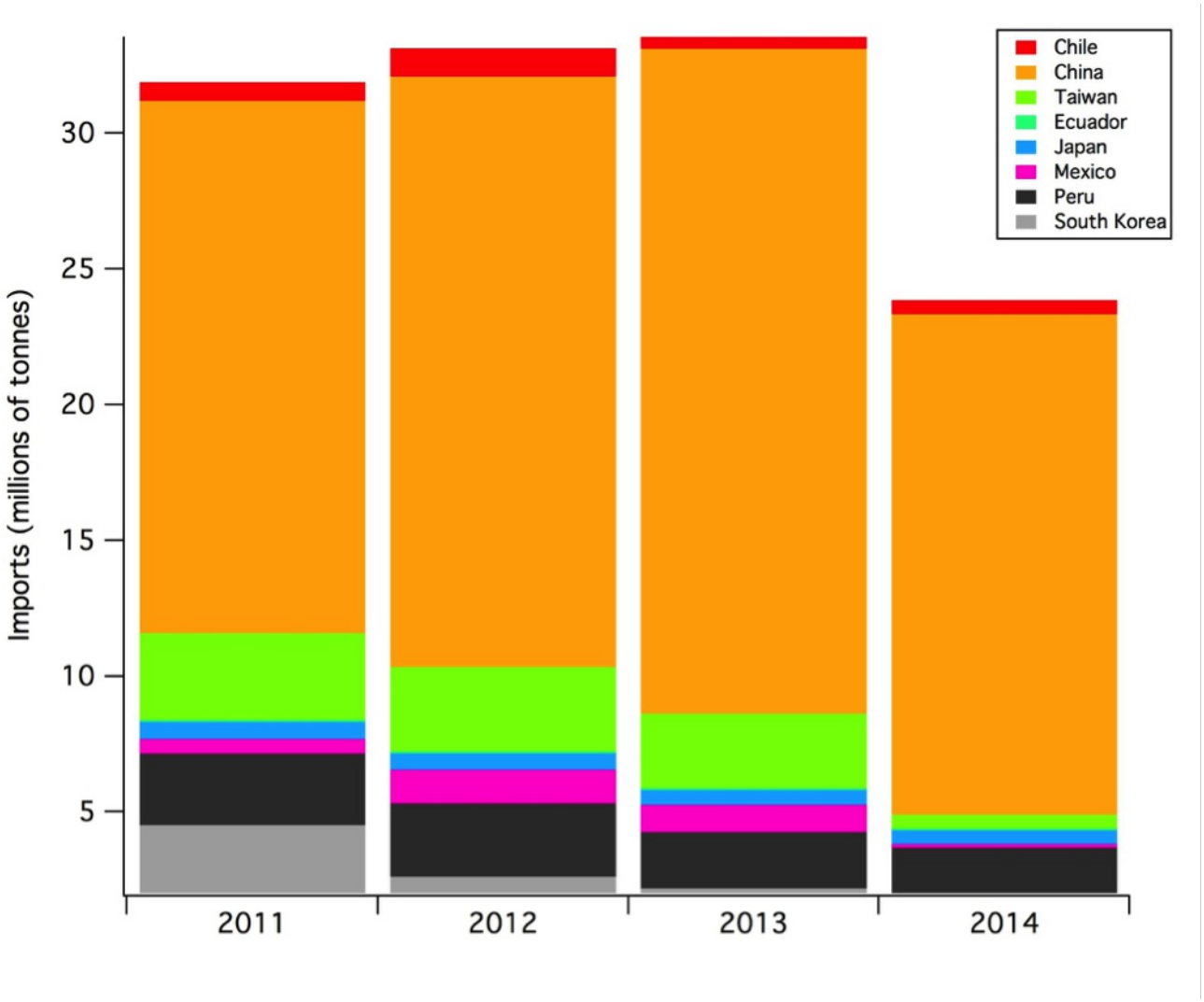

Figure 4 US imports of "Squid NSPF" (squid of unspecified species) by exporting nation (NMFS 2014).

Common and market names.

Humboldt squid, jumbo squid, jumbo flying squid, calamar gigante, pota (Peru), jibia (Chile). May also be sold in the US simply as squid or calamari.

Primary product forms

The majority of squid products for human consumption are imported frozen, either whole, in fillets, or rings. Humboldt squid is also sold boiled, pickled, as jerky (or "sakiika"), salted and fermented ("shiokara"), and mixed with other seafood, although these forms are less common in North American markets.

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

JUMBO SQUID			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
Chile/Southeast Pacific | Jig | Chile	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)
Peru/Southeast Pacific | Jig | Peru	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.640)
Southeast Pacific | Jig | China	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)

Criterion 1 Assessment

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.*

JUMBO SQUID

Factor 1.1 - Abundance

CHILE/SOUTHEAST PACIFIC, JIG, CHILE

Moderate Concern

Information on the stock status of *Dosidicus gigas* off the coast of South America remains limited. Nigmatullin proposed three sub-unit stocks based on differences in the size at which individuals reach maturity (Nigmatullin et al. 2001), though later work found no relevant genetic differences between the proposed sub-units (Sandoval-Castellanos et al. 2010). Chile's Subpesca has declined to define biological reference points with respect to the Humboldt Current population (CCT-RDZCS 2013) (CCT-RDZCS 2014), and current reference points and biomass estimates from Peru's IMARPE are not available. Using CPUE as a proxy for biomass abundance, China has recently assessed the (assumed single) stock that they fish outside the Chilean and Peruvian EEZs, and found the stock not overfished ($B_{CURRENT}>B_{MSY}$) (Xu et al. 2017). However, limited data were available for this assessment (fisheries-dependent data from China only; no data from Peru or Chile, and no fisheries-independent data). Thus, although some indicators suggest the stock is healthy, there is currently too much uncertainty to score a "very low" or "low" concern; therefore, it is scored as "moderate" concern.

Justification:

Research efforts are underway to improve knowledge on the impacts of fishing on the South Pacific jumbo squid. IMARPE evaluates biomass off the coast of Peru with hydroacoustic methods (Argüelles and Tafur 2010), with values ranging between 2.51 and 2.96 million MT for the period 2001 to 2011 (Arkhipkin 2015). Estimates of Chilean biomass have been made using both hydroacoustic surveys (ranging between ~40,400 to ~682,600 t within the period from 2001 to 2006) (Alarcón-Muñoz et al. 2008) and Ecopath modeling (~400,000 t in 2005) (Arancibia and Neira 2008). However, the accuracy of these methods in the case of *D. gigas* is unclear (Morales-Bojórquez, et al. 2001). Abundance has been highly variable, and recruitment appears to be linked to environmental conditions.

China's recent stock assessment (Xu et al. 2017) used CPUE to represent the biomass abundance index, but that assumes the stock biomass has a constant catchability, which Xu and colleagues do not address. Although the stock assessment was presented at the SPRFMO Scientific Committee meeting from September 2017 and likely not peer-reviewed, the methods employed are the same ones used by the National Oceanic and Atmospheric Administration. Because the stock assessment used only fishery-dependent data and only from

one of the fisheries on jumbo squid in the region, uncertainty remains high.

Factor 1.2 - Fishing Mortality

CHILE/SOUTHEAST PACIFIC, JIG, CHILE

Moderate Concern

Chile and Peru both conduct assessments of the stock, and both countries observe catch limits that are below F_{MSY} (Subpesca 2012a) (Sernapesca 2014) (Argüelles 2012) (Carbajal-Villalta 2009) (IMARPE 2010) (PRODUCE 2012b). China has conducted one stock assessment as of 2016 and found fishing mortality to be no more than F_{MSY} and therefore concluded overfishing was not occurring (Xu et al. 2017). However, the age of the reports from Chile and Peru and the limited data used in the Chinese assessment suggests a "moderate" concern is appropriate for these fisheries.

Justification:

The Humboldt squid is the target of the largest global invertebrate fishery in the world by volume (Rosa et al 2013). Global catches have increased from 210,000 MT in 2000 to 847,000 MT in 2013, with the highest catch (950,000 MT) caught in 2012 (FAO 2014b). In 2013, 847,292 MT were caught, all but 11,132 MT off Chile and Peru (the remainder was caught by Mexico) (FAO 2014b). Of this 836,160 MT, approximately 54% (over 450,000 MT) were caught by Peru and nearly 13% (264,000 MT) by Chile. Virtually all of the remaining 32% was caught by China (FAO 2014b).

Chile currently uses historical yields to calculate maximum constant yield (MCY) and assign a global quota or total allowable catch (TAC) for the species across all fishery regions (Subpesca 2012a). Catch has stayed well below this MCY for both 2012 and 2013 (Sernapesca 2014). Subpesca has since commissioned a study to evaluate new management methods (see Proyecto 2013-18 in (FIP 2013)). Fisheries documents refer to the stock as “fully exploited” (Subpesca 2014a).

Through IMARPE, Peru sets an initial global quota at less than 2/3 MSY, which is then altered over the course of the season in accordance with midseason biomass estimates. Catch has stayed below or at the recommended catch from 2008 to 2012 with the exception of 2009, when total allowable catch, but not F_{MSY}, was exceeded (Argüelles 2012)(Carbajal-Villalta 2009) (IMARPE 2010) (PRODUCE 2012b). PRODUCE described the stock as underexploited in its last publicly available statement on the fishery (PRODUCE 2012b).

Chinese catch has steadily increased to peak at 325,000 tonnes in 2014 with a slight decline to 323,600 in 2015 (Li et al. 2016). China does not appear to have any quotas or recommendations set for the fishery. A recent stock assessment employing a Bayesian state-space surplus production model showed F/F_MSY ranging from 0.4 to just under 1, indicating that fishing mortality is either below or around MSY (Xu et al. 2017). Xu and colleagues concluded that the stock was not overfished or subject to overfishing using CPUE as a proxy for biomass. However, there were no fishery-independent data contributing to the stock assessment.

See Harvest Strategy for details on the definition of MCY.

JUMBO SQUID

Factor 1.1 - Abundance

PERU/SOUTHEAST PACIFIC, JIG, PERU

Moderate Concern

Information on the stock status of *Dosidicus gigas* off the coast of South America remains limited. Nigmatullin proposed three sub-unit stocks based on differences in the size at which individuals reach maturity (Nigmatullin et al. 2001), though later work found no relevant genetic differences between the proposed sub-units (Sandoval-Castellanos et al. 2010). Chile's Subpesca has declined to define biological reference points with respect to the Humboldt Current population (CCT-RDZCS 2013) (CCT-RDZCS 2014), and current reference points and biomass estimates from Peru's IMARPE are not available. Using CPUE as a proxy for biomass abundance, China has recently assessed the (assumed single) stock that they fish outside the Chilean and Peruvian EEZs, and found the stock not overfished ($B_{CURRENT}>B_{MSY}$) (Xu et al. 2017). However, limited data were available for this assessment (fisheries-dependent data from China only; no data from Peru or Chile, and no fisheries-independent data). Thus, although some indicators suggest the stock is healthy, there is currently too much uncertainty to score a "very low" or "low" concern; therefore, it is scored as "moderate" concern.

Justification:

Research efforts are underway to improve knowledge on the impacts of fishing on the South Pacific jumbo squid. IMARPE evaluates biomass off the coast of Peru with hydroacoustic methods (Argüelles and Tafur 2010), with values ranging between 2.51 and 2.96 million MT for the period 2001 to 2011 (Arkhipkin 2015). Estimates of Chilean biomass have been made using both hydroacoustic surveys (ranging between ~40,400 to ~682,600 t within the period from 2001 to 2006) (Alarcón-Muñoz et al. 2008) and Ecopath modeling (~400,000 t in 2005) (Arancibia and Neira 2008). However, the accuracy of these methods in the case of *D. gigas* is unclear (Morales-Bojórquez, et al. 2001). Abundance has been highly variable, and recruitment appears to be linked to environmental conditions.

China's recent stock assessment (Xu et al. 2017) used CPUE to represent the biomass abundance index, but that assumes the stock biomass has a constant catchability, which Xu and colleagues do not address. Although the stock assessment was presented at the SPRFMO Scientific Committee meeting from September 2017 and likely not peer-reviewed, the methods employed are the same ones used by the National Oceanic and Atmospheric Administration. Because the stock assessment used only fishery-dependent data and only from one of the fisheries on jumbo squid in the region, uncertainty remains high.

Factor 1.2 - Fishing Mortality

PERU/SOUTHEAST PACIFIC, JIG, PERU

Moderate Concern

Chile and Peru both conduct assessments of the stock, and both countries observe catch limits that are below F_{MSY} (Subpesca 2012a) (Sernapesca 2014) (Argüelles 2012) (Carbajal-Villalta 2009) (IMARPE 2010) (PRODUCE 2012b). China has conducted one stock assessment as of 2016 and found fishing mortality to be no more than F_{MSY} and therefore concluded overfishing was not occurring (Xu et al. 2017). However, the age of the reports from Chile and Peru and the limited data used in the Chinese assessment suggests a "moderate" concern is appropriate for these fisheries.

Justification:

The Humboldt squid is the target of the largest global invertebrate fishery in the world by volume (Rosa et al 2013). Global catches have increased from 210,000 MT in 2000 to 847,000 MT in 2013, with the highest catch (950,000 MT) caught in 2012 (FAO 2014b). In 2013, 847,292 MT were caught, all but 11,132 MT off Chile and Peru (the remainder was caught by Mexico) (FAO 2014b). Of this 836,160 MT, approximately 54% (over 450,000 MT) were caught by Peru and nearly 13% (264,000 MT) by Chile. Virtually all of the remaining 32%

was caught by China (FAO 2014b).

Chile currently uses historical yields to calculate maximum constant yield (MCY) and assign a global quota or total allowable catch (TAC) for the species across all fishery regions (Subpesca 2012a). Catch has stayed well below this MCY for both 2012 and 2013 (Sernapesca 2014). Subpesca has since commissioned a study to evaluate new management methods (see Proyecto 2013-18 in (FIP 2013)). Fisheries documents refer to the stock as "fully exploited" (Subpesca 2014a).

Through IMARPE, Peru sets an initial global quota at less than 2/3 MSY, which is then altered over the course of the season in accordance with midseason biomass estimates. Catch has stayed below or at the recommended catch from 2008 to 2012 with the exception of 2009, when total allowable catch, but not F_{MSY}, was exceeded (Argüelles 2012)(Carbajal-Villalta 2009) (IMARPE 2010) (PRODUCE 2012b). PRODUCE described the stock as underexploited in its last publicly available statement on the fishery (PRODUCE 2012b).

Chinese catch has steadily increased to peak at 325,000 tonnes in 2014 with a slight decline to 323,600 in 2015 (Li et al. 2016). China does not appear to have any quotas or recommendations set for the fishery. A recent stock assessment employing a Bayesian state-space surplus production model showed F/F_MSY ranging from 0.4 to just under 1, indicating that fishing mortality is either below or around MSY (Xu et al. 2017). Xu and colleagues concluded that the stock was not overfished or subject to overfishing using CPUE as a proxy for biomass. However, there were no fishery-independent data contributing to the stock assessment.

See Harvest Strategy for details on the definition of MCY.

JUMBO SQUID

Factor 1.1 - Abundance

SOUTHEAST PACIFIC, JIG, CHINA

Moderate Concern

Information on the stock status of *Dosidicus gigas* off the coast of South America remains limited. Nigmatullin proposed three sub-unit stocks based on differences in the size at which individuals reach maturity (Nigmatullin et al. 2001), though later work found no relevant genetic differences between the proposed sub-units (Sandoval-Castellanos et al. 2010). Chile's Subpesca has declined to define biological reference points with respect to the Humboldt Current population (CCT-RDZCS 2013) (CCT-RDZCS 2014), and current reference points and biomass estimates from Peru's IMARPE are not available. Using CPUE as a proxy for biomass abundance, China has recently assessed the (assumed single) stock that they fish outside the Chilean and Peruvian EEZs, and found the stock not overfished ($B_{CURRENT}>B_{MSY}$) (Xu et al. 2017). However, limited data were available for this assessment (fisheries-dependent data from China only; no data from Peru or Chile, and no fisheries-independent data). Thus, although some indicators suggest the stock is healthy, there is currently too much uncertainty to score a "very low" or "low" concern; therefore, it is scored as "moderate" concern.

Justification:

Research efforts are underway to improve knowledge on the impacts of fishing on the South Pacific jumbo squid. IMARPE evaluates biomass off the coast of Peru with hydroacoustic methods (Argüelles and Tafur 2010), with values ranging between 2.51 and 2.96 million MT for the period 2001 to 2011 (Arkhipkin 2015). Estimates of Chilean biomass have been made using both hydroacoustic surveys (ranging between ~40,400 to ~682,600 t within the period from 2001 to 2006) (Alarcón-Muñoz et al. 2008) and Ecopath modeling (~400,000 t in 2005) (Arancibia and Neira 2008). However, the accuracy of these methods in the case of *D.*

gigas is unclear (Morales-Bojórquez, et al. 2001). Abundance has been highly variable, and recruitment appears to be linked to environmental conditions.

China's recent stock assessment (Xu et al. 2017) used CPUE to represent the biomass abundance index, but that assumes the stock biomass has a constant catchability, which Xu and colleagues do not address. Although the stock assessment was presented at the SPRFMO Scientific Committee meeting from September 2017 and likely not peer-reviewed, the methods employed are the same ones used by the National Oceanic and Atmospheric Administration. Because the stock assessment used only fishery-dependent data and only from one of the fisheries on jumbo squid in the region, uncertainty remains high.

Factor 1.2 - Fishing Mortality

SOUTHEAST PACIFIC, JIG, CHINA

Moderate Concern

Chile and Peru both conduct assessments of the stock, and both countries observe catch limits that are below F_{MSY} (Subpesca 2012a) (Sernapesca 2014) (Argüelles 2012) (Carbajal-Villalta 2009) (IMARPE 2010) (PRODUCE 2012b). China has conducted one stock assessment as of 2016 and found fishing mortality to be no more than F_{MSY} and therefore concluded overfishing was not occurring (Xu et al. 2017). However, the age of the reports from Chile and Peru and the limited data used in the Chinese assessment suggests a "moderate" concern is appropriate for these fisheries.

Justification:

The Humboldt squid is the target of the largest global invertebrate fishery in the world by volume (Rosa et al 2013). Global catches have increased from 210,000 MT in 2000 to 847,000 MT in 2013, with the highest catch (950,000 MT) caught in 2012 (FAO 2014b). In 2013, 847,292 MT were caught, all but 11,132 MT off Chile and Peru (the remainder was caught by Mexico) (FAO 2014b). Of this 836,160 MT, approximately 54% (over 450,000 MT) were caught by Peru and nearly 13% (264,000 MT) by Chile. Virtually all of the remaining 32% was caught by China (FAO 2014b).

Chile currently uses historical yields to calculate maximum constant yield (MCY) and assign a global quota or total allowable catch (TAC) for the species across all fishery regions (Subpesca 2012a). Catch has stayed well below this MCY for both 2012 and 2013 (Sernapesca 2014). Subpesca has since commissioned a study to evaluate new management methods (see Proyecto 2013-18 in (FIP 2013)). Fisheries documents refer to the stock as “fully exploited” (Subpesca 2014a).

Through IMARPE, Peru sets an initial global quota at less than 2/3 MSY, which is then altered over the course of the season in accordance with midseason biomass estimates. Catch has stayed below or at the recommended catch from 2008 to 2012 with the exception of 2009, when total allowable catch, but not F_{MSY}, was exceeded (Argüelles 2012)(Carbajal-Villalta 2009) (IMARPE 2010) (PRODUCE 2012b). PRODUCE described the stock as underexploited in its last publicly available statement on the fishery (PRODUCE 2012b).

Chinese catch has steadily increased to peak at 325,000 tonnes in 2014 with a slight decline to 323,600 in 2015 (Li et al. 2016). China does not appear to have any quotas or recommendations set for the fishery. A recent stock assessment employing a Bayesian state-space surplus production model showed F/F_MSY ranging from 0.4 to just under 1, indicating that fishing mortality is either below or around MSY (Xu et al. 2017). Xu and colleagues concluded that the stock was not overfished or subject to overfishing using CPUE as a proxy for biomass. However, there were no fishery-independent data contributing to the stock assessment.

See Harvest Strategy for details on the definition of MCY.

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

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix A.

JUMBO SQUID - CHILE/SOUTHEAST PACIFIC - JIG - CHILE					
Subscore:	**5.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**5.000**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
No other main species caught					

JUMBO SQUID - PERU/SOUTHEAST PACIFIC - JIG - PERU					
Subscore:	**5.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**5.000**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
No other main species caught					

JUMBO SQUID - SOUTHEAST PACIFIC - JIG - CHINA					
Subscore:	**5.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**5.000**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
No other main species caught					

2.4 - Discards + Bait / Landings

CHILE / SOUTHEAST PACIFIC, JIG, CHILE
PERU / SOUTHEAST PACIFIC, JIG, PERU
SOUTHEAST PACIFIC, JIG, CHINA

< 100%

Discard rates are largely unavailable, but jig fisheries are typically highly selective (Boyle and Rodhouse 2005), with a discard rate of 0.1% (Kelleher 2005).

Justification:

In accordance with its 2012 fisheries discards law, Chile is currently introducing an onboard observer program in its industrial fisheries (Cocas 2014) (Subpesca 2012d), with the *D. gigas* trawl fishery to be included within the next two years (pers. comm., Patricio Galvez, IFOP 2018). In Peru, IMARPE places scientific observers aboard foreign industrial squid jiggers within its EEZ (PRODUCE 2011), but artisanal landings are evaluated at port (IMARPE 2013a). An observer program exists for the Chinese high-seas fishery, but results from the program remain unknown (Li et al. 2016). SPRFMO has recommended implementing their own observer program specifically for the high seas *D. gigas* fishery, but it is currently only at the conceptual stage (Argüelles et al. 2016). Although bycatch and discard rates are low for the this fishery, SPRFMO's goal for such an observer program focuses on collecting biological data on *D. gigas,* including length, weight-at-length, sex, and maturity, or in case data at a higher resolution than that provided by their existing templates are needed (Argüelles et al. 2016).

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.

Criterion 3 Summary

Fishery	Management Strategy	Bycatch Strategy	Research and Monitoring	Enforcement	Stakeholder Inclusion	Score
Fishery 1: Southeast Pacific | Jig | China	Moderately Effective	Highly Effective	Moderately Effective	Ineffective	Ineffective	Red (2.000)
Fishery 2: Chile / Southeast Pacific | Jig | Chile	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Moderately Effective	Yellow (3.000)
Fishery 3: Peru / Southeast Pacific | Jig | Peru	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Moderately Effective	Yellow (3.000)

Criterion 3 Assessment

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.

SOUTHEAST PACIFIC, JIG, CHINA
CHILE / SOUTHEAST PACIFIC, JIG, CHILE
PERU / SOUTHEAST PACIFIC, JIG, PERU

Moderately Effective

Chile and Peru are both deemed to have moderately effective management strategies and implementation programs. Both catch Humboldt squid only within their EEZs, and both have implemented management measures since 2012 (see below). The effectiveness of each country's strategy is as yet untested (given that each has only been in place for a few fishing seasons), but both policies still have weaknesses in terms of regulation during years of low abundance (i.e., they do not define a minimum biomass below which fishing should not occur) and ability to estimate each year's exploitable biomass through annual pre-fishing season surveys (as strongly recommended for cephalopod fisheries by researchers, e.g., (Rodhouse et al. 2014)). In contrast, China's management strategy is relatively unknown though not absent entirely, and the considerable catch made by China on the high seas weakens the overall management strategy.

Chile

Management of the squid fishery in Chile started in 2012. Fisheries legislation demonstrates concern for scientific advice and the precautionary principle: legislation specifically cites input of local scientific committees, and the squid fishery has recently been closed to new permit holders because the resource is no longer deemed underexploited (Subpesca 2014e). There are, however, no explicit limits on the number of artisanal permitholders (Subpesca 2013a). No reference points have been developed for the fishery, so Subpesca currently sets the fishery's modifiable TAC using an maximum constant yield based on the historical catch from 2004 to 2010 (Subpesca 2013a).

Peru

IMARPE estimates an initial MSY using historic CPUE/landings data and adjusts according to direct hydroacoustic stock assessments. This MSY is used to generate a global quota at <2/3 of MSY (PRODUCE 2012d). Production statistics for the artisanal fishery are collected by dockside observers and reported to PRODUCE, while the foreign industrial fleet is monitored by onboard observers, and vessel monitoring systems. A permit is required to participate in the fishery.

China

A number of ordinances from China's Ministry of Agriculture (MOA) and the Fisheries Management Board of China provide the beginnings of regulatory structure, mainly for vessel compliance as opposed to specifics on fishery management (Xue 2006). Any regulations on fisheries themselves, such as catch quotas, vessel numbers, and recommended fishing levels, come from regional fishery bodies in which China is an active partner. The few regulatory measures in existence for the *D. gigas* fishery off of Peruvian and Chilean EEZs are stipulated by the SPRFMO (Arugelles et al. 2016).

Justification:

Chile

The 2012 TAC, which has set the template for the following years' quotas, analyzes the annual catch from 2004 to 2010 using Annala's maximum constant yield method: MCY = cYav (cited in Subpesca, 2012a as

(Francis 1992)) where Yav is the average catch over a period of time, and c is the natural variability in the biomass of the stock. For 2012, Yav over the period of interest equalled ~167,000 tonnes. Subpesca assigned c a value near or equal to 1 based on D. gigas's presumed "resilience and productivity," resulting in the highest possible calculated MCY. Additionally, the final TAC was set at 200,000 tonnes, above this MCY, on the assumption that the stock was underexploited.

4000 tonnes of the quota are reserved for research. Of the remaining 196,000, 80% is reserved for artisanal fishers and 20% for industrial vessels. In the artisanal sector, an additional percentage can be captured as bycatch in other fisheries. Although this fractioning plan was suspended in 2014 (Subpesca 2014c), it has been reapproved for the years 2014 to 2019 (Subpesca 2014b).

Fisheries legislation demonstrates concern for scientific advice and the precautionary principle: legislation specifically cites input of local scientific committees, and the squid fishery has recently been closed to new permit holders because the resource is no longer deemed underexploited (Subpesca 2014e). There are, however, no explicit limits on the number of artisanal permit holders (Subpesca 2013a), and Chile has been criticized for its historic response to overfishing and environmental change (Kalikoski, et al 2006b). Reported catch has never exceeded the TAC (Sernapesca 2014). The lack of abundance data suggests that the quota, set above the perceived capacity of the artisanal fleet in 2012, is likely to increase as the artisanal fleet expands (pers. comm., Liesbeth van der Meer, Oceana Chile 2018).

Peru

Since 2010, the MSY has been calculated using the Schaefer Biomass Dynamic Model, with the assumption that catch varies with sea surface temperature (Argüelles 2012) (for *D. gigas* population parameters from the Schaefer model, see (Arkhipkin et al. 2015)). MSY from 2001 to 2011 has been estimated at around 991,514 tonnes. In 2012, this MSY was calculated as 854,859 tonnes in 2012, which led to the establishment of a global quota of 500,000 tonnes (PRODUCE 2012d). This quota may be adjusted over the course of the season based on monthly fisheries reports and midseason hydroacoustic surveys (IMARPE 2013b). Earlier in the fishery's history, global quotas were set using CPUE values, from 1991 to 1998, and using hydroacoustic surveys from 1999 to 2009, coupled with Schaefer and Fox production models (Arkhipkin et al. 2015).

Fisheries legislation demonstrates concern for scientific advice and the precautionary principle: the Ley General de la Pesca specifically requires that IMARPE recommend annual quotas for stocks and conduct research to validate its recommendations (PRODUCE 2014). There has been criticism of Peru's historically slow response to overfishing, but praise for management's response to environmental change (notably, IMARPE explicitly includes sea surface temperature monitoring when evaluating the squid fishery) (Kalikoski, et al 2006a) (Argüelles 2012). There are no explicit limits on the number of artisanal permit holders, and the TAC has been exceeded once, in 2009 (IMARPE 2010). If established quotas are exceeded in the course of the season, the Ley General de la Pesca requires that all "extractive activities" be suspended (PRODUCE 2014).

China

The directed guidelines given by the Chinese management strategy comes from the 2003 Regulations on Distant Water Fisheries adopted by MOA. It provides requirements for vessel license application, catch reporting duties, vessel surveillance, and penalties for violations (Xue 2006). Unlike Peru and Chile, no quotas or regular stock assessments exist; however, a preliminary stock assessment in 2016 and a more detailed follow-up in 2017 found no evidence that the stock is overfished or subject to overfishing (Xu et al. 2016) (Xu et al. 2017). Although the use of CPUE as a proxy for biomass may be a concern (Probst and Oesterwind 2014), the authors demonstrate that CPUE is a valid proxy in this scenario (Xu et al. 2017). Collection of fishery-independent data to estimate abundance would be required to improve the management strategy of this fishery.

The SPRFMO Scientific Committee (SC) is tasked with squid stock assessment and provision of scientific advice to the SPRFMO Commission. Initial steps addressing regulation of the high-seas jumbo squid fishery were discussed at the 2016 meeting of the SPRFMO SC (Arugelles et al. 2016). Subsequent work in the 2017 meeting focused on stock assessments, thus paving the way for future management decisions (Xu et al. 2017) (Li et al. 2017). Specific instructions were issued to standardize reporting and documentation of catch data, fishing effort or activity, and biological data for all taking parties in the Humboldt squid fishery to the SPRFMO database. Because these measures are in their nascent stages, implementation and enforcement remain to be seen, but a timeline of full management implementation is in the works for future meetings.

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.

SOUTHEAST PACIFIC, JIG, CHINA
CHILE / SOUTHEAST PACIFIC, JIG, CHILE
PERU / SOUTHEAST PACIFIC, JIG, PERU

Highly Effective

Jigging is a highly selective harvest strategy for targeting squid, and bycatch is very low as a result.

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.

SOUTHEAST PACIFIC, JIG, CHINA
CHILE / SOUTHEAST PACIFIC, JIG, CHILE
PERU / SOUTHEAST PACIFIC, JIG, PERU

Moderately Effective

Chile, Peru, and China all have research and monitoring programs in place for *D. gigas*. However, the lack of coordinated assessment (and recent assessment by Chile and Peru) using fisheries-dependent and fisheries-independent sources across all fisheries weakens the overall effectiveness of the research and monitoring programs in place. This criterion is thus scored "moderately" effective.

As there are no bycatch concerns, no research and monitoring is necessary to mitigate the impacts of the fishery on other species.

Justification:

In Chile, although IFOP has begun or is planning to conduct studies on D. gigas stock assessment, assessments have thus far been sporadic and incomplete. Methods used include hydroacoustic surveys (Alarcón-Muñoz et al. 2008), Ecopath modeling (Arancibia and Neira 2008), and incidental sampling from hake research trawl bycatch.

In Peru, IMARPE conducts regular hydroacoustic stock assessments in addition to delivering monthly reports

on the state of the fishery. These are based on CPUE and size-age structure of landings (IMARPE 2013b), although the accuracy of these methods in the case of D. gigas is unclear (Morales-Bojórquez et al. 2001). Environmental data (such as surface temperature) are also monitored (Argüelles 2012).

The majority of China's research on D. gigas in the southeast Pacific is coordinated by scholars based at Shanghai Ocean University. Although decent work has been completed on D. gigas biology, including maturation, growth, and population structure (e.g., (Chen et al. 2011) (Liu et al. 2013) (Liu et al. 2015)), and the potential effects of climate changes on squid range (Yu and Chen 2018) (Yu et al. 2016) (Yu et al. 2017), less is known about the stock abundance, although a preliminary stock assessment and more detailed follow-up have been recently completed (Xu et al. 2016) (Xu et al. 2017). Although the use of CPUE as a proxy for biomass may be a concern (Probst and Oesterwind 2014), the authors demonstrate that CPUE is a valid proxy in this scenario (Xu et al. 2017). Collection of fishery-independent data to estimate abundance would be required to improve the management strategy of this fishery.

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.

SOUTHEAST PACIFIC, JIG, CHINA

Ineffective

Although enforcement had been essentially nonexistent, recent improvements have been made, especially given the increase in China's distant water fishing activity. Among many laws that have been enacted, the Regulations on Distant Water Fisheries (DWF) adopted by China's Ministry of Agriculture in 2003 laid down substantial groundwork for enforcement and penalties in the case of violations (Xue 2006). The Regulations on DWF outline vessel license qualifications, specifically concentrating on previous track records. Similar to regulations adopted by the SPRFMO in 2016 (Arguelles et al. 2016), vessels are required to report their catches, species, landings, and value. In addition, vessels are expected to complete logbooks, carry VMS, and participate in observer programs. However, it is not at all clear if and how these regulations are enforced. At the same time, the problem of illegal, unreported or undocumented fishing on the high seas, despite strong efforts to resolve them for more than a decade (High Seas Task Force 2006), persists to this day, e.g., (Stop Illegal Fishing, Trygg Mat Tracking and NFDS 2017). Given the continuing problems of IUU on the high seas, and the lack of evidence that regulations (where they exist) are being effectively enforced, enforcement is considered "ineffective."

CHILE / SOUTHEAST PACIFIC, JIG, CHILE

Moderately Effective

Weak enforcement of laws pertaining to bycatch, discards, and unreported fishing (Perez 2005) (OECD 2009) (Pramod et al. 2014) is beginning to be addressed by stricter scientific monitoring, as required by Ley 20.625 ((Subpesca 2012d), explained in (Cocas 2014)). Fishing licenses are required and assigned by fishery, area, and vessel monitoring systems (VMS) are currently mandatory on all large scale fishing vessels (FAO 2010b), with enforcement of registration effected by the Chilean Navy. This designation includes artisanal vessels in the 12 to 18m size range. Production statistics reporting is mandatory and enforced in both industrial and artisanal sectors (NFS 2004). In-person port monitoring of the artisanal sector is, however, limited, with only 7% of artisanal landings inspected in 2012 (Sernapesca 2013b). Reported catch has remained below the TAC for both 2012 and 2013 (Sernapesca 2014).

PERU / SOUTHEAST PACIFIC, JIG, PERU

Highly Effective

Licensing, onboard observers, and vessel monitoring systems (the satellite surveillance system SISESTAT) are required in the industrial fisheries. Catch in the artisanal fisheries is monitored by IMARPE on shore (e.g., see (IMARPE 2013a)). Production statistics reporting is mandatory and enforced in both industrial and artisanal sectors. Captures have largely stayed below or at the recommended catch in recent years.

Justification:

Specific information on the vessel monitoring system is available from (FAO 2010c). Resolución Ministerial No 415-2001-PE establishes the system of data collection for artisanal fisheries (PRODUCE 2001). See Fishing Mortality for details on adherence to recommended catch limits.

The industrial fishery is restricted to dedicated jigging vessels that operate within 30 to 200 miles of the Peruvian coast. Specimens must have a minimum mantle length of 320 mm, and small squid must not comprise more than 20% of total catch (Arkhipkin et al. 2015).

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.

SOUTHEAST PACIFIC, JIG, CHINA

Ineffective

Chinese law asserts that the nation owns natural fisheries resources, and fishers are formally recognized due to their direct relation to such resources (Cheng et al. 2006). Because at least 70% of the distant water fisheries are privately owned enterprises, it is unclear who participates in the decision-making process besides the companies themselves. Although China's entry into the South Pacific Regional Fisheries Management Organisation provides more centralized management, SPRFMO's efforts on stakeholder inclusion has mainly focused on bottom fisheries and have yet to include the jumbo flying squid fishery.

CHILE / SOUTHEAST PACIFIC, JIG, CHILE

Moderately Effective

Artisanal fishers have formal recognition, are officially and non-transferably registered by Sernapesca, and have protected quotas and a five-mile exclusive fishing zone near shore. Artisanal and industrial fisheries have, however, clashed in recent years over alleged inequities in the allocation of quotas (Nelsen 2013). Recent adoption of measures such as TURFs (Áreas de Manejo y Explotación de Recursos Bentónicos) in some fisheries appear more stakeholder-inclusive (Gelcich et al. 2010). Catch statistics are published.

PERU / SOUTHEAST PACIFIC, JIG, PERU

Moderately Effective

Artisanal fishers are officially recognized, and their development is provided for by fishery development fund FONDEPES. The five-mile zone near shore is reserved for artisanal fisheries using low-impact gear types. A 2006 evaluation of Peru's adherence to the UN Code of Conduct for Responsible Fisheries found that individual fisheries allowed for stakeholder participation, but that there was no specific requirement for a stakeholder-inclusive decision-making process (Kalikoski 2006). Catch statistics are published.

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

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
Chile / Southeast Pacific / Jig / Chile	5	0	Moderate Concern	Green (3.873)
Peru / Southeast Pacific / Jig / Peru	5	0	Moderate Concern	Green (3.870)
Southeast Pacific / Jig / China	5	0	Moderate Concern	Green (3.873)

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 - Physical Impact of Fishing Gear on the Habitat/Substrate

SOUTHEAST PACIFIC, JIG, CHINA
CHILE / SOUTHEAST PACIFIC, JIG, CHILE
PERU / SOUTHEAST PACIFIC, JIG, PERU

5

Humboldt squid are pelagic organisms, and jigs rarely contact the seafloor. Jigging is a low-impact gear type with no bottom contact (Arkhipkin, et al. 2015).

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

SOUTHEAST PACIFIC, JIG, CHINA
CHILE / SOUTHEAST PACIFIC, JIG, CHILE
PERU / SOUTHEAST PACIFIC, JIG, PERU

0

No mitigation necessary.

Factor 4.3 - Ecosystem-Based Fisheries Management

SOUTHEAST PACIFIC, JIG, CHINA
CHILE / SOUTHEAST PACIFIC, JIG, CHILE
PERU / SOUTHEAST PACIFIC, JIG, PERU

Moderate Concern

Since 2002, Chile and Peru have been collaborating on the Global Environment Facility-funded joint management of the Humboldt Current Large Marine Ecosystem (HCLME) (UNDP 2015), which includes establishment of international Marine Protected Areas (Kalikoski 2006). A 2009 evaluation of fisheries in the context of ecosystem-based management gave Peru just above a passing grade, and Chile a failing grade (Pitcher et al. 2009), but *D. gigas* is an active area of research in both countries (Alegre et al. 2014) (see detailed rationale) and is therefore deemed of "moderate" concern. As of 2006, China's ecosystem-based fisheries research and management was given a failing grade in an evaluation (Cheng et al. 2006). However, similar to Chile, China has maintained active research in the biology and ecology of the species in years since Cheng et al.'s evaluation. Moreover, SPRFMO is working towards management strategies based on squid ecology, so the Chinese fishery is also graded as "moderate" concern.

Justification:

Humboldt squid act as both a major predator of a wide variety of small mesopelagic organisms (Alarcón-Muñoz et al. 2008) (Field et al. 2007) (Markaida and Sosa-Nishizaki 2003), and a major forage species for top vertebrate predators (Nigmatullin et al. 2001) (Field, et al 2007), placing it in a bridging mesopredator position and granting it exceptional importance. Although much of the ecology of *D. gigas* is unknown, its sheer biomass also grants it a significant, if annually variable, trophic role.

The species' recent population growth and range expansion, along with that of other cephalopods, has been attributed to reduced competition as a result of overexploitation of groundfish stocks (Caddy and Rodhouse 1998), top-down forcing as a result of tuna and billfish population declines (Zeidberg and Robison 2007), and climate change, potentially as a result of an expanding oxygen minimum layer or unusual ENSO regime (Field et al. 2007) (Gilly et al. 2013) (Keyl et al. 2008). The apparent coincidence of *D. gigas*' expansion and the decline of the Chilean hake fishery has also led to a widespread belief among fishers that squid predation has

caused a decline in hake populations (pers. comm., Patricio Galvez, IFOP 2018), but this is not generally supported by models (Arancibia and Neira 2008) (Ibáñez 2013). Political pressure stemming from this viewpoint may lead to insufficiently cautious management approaches. Fisheries are urged to avoid this temptation: estimates suggest that global predation on squid exceeds current fishing mortality (FAO 2005), meaning overfishing could trigger significant cascading effects. Furthermore, the 2016 SPRFMO Scientific Committee meeting warned that, because *D. gigas* appears to be sensitive to certain environmental conditions, nations should not wait for a collapse due to unfavorable conditions to enact management (Argüelles et al. 2016).

In its evaluation of EBFM in Chilean fisheries, Kalikoski et al. specifically noted a lack of recognition of human impacts on fishery habitat and fisheries' effects on "species linked through the ecosystem to the target [species]" (Kalikoski et al. 2006b). In a similar evaluation, China was found to not explicitly state restrictions in any management plans on fishing if ecologically linked species may be impacted (Cheng et al. 2006).

Acknowledgements

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.

Seafood Watch would like to thank the consulting researcher and author of this report, Diana Li, as well as Bilin Liu and an anonymous reviewer for graciously reviewing this report for scientific accuracy.

References

ACAP. 2014. Agreement on the Conservation of Albatrosses and Petrels. Retrieved from http://www.acap.aq/

Alarcón-Muñoz, R., Cubillos, L., & Gatica, C. 2008. Jumbo squid (Dosidicus gigas) biomass off central Chile: effects on Chilean hake (Merluccius gayi). CalCOFI Report 49:157–166.

Ana Alegre, Frédéric Ménard, Ricardo Tafur, Pepe Espinoza, Juan Argüelles, Víctor Maehara, Oswaldo Flores, Monique Simier, Arnaud Bertrand, 2014. Comprehensive Model of Jumbo Squid Dosidicus gigas Trophic Ecology in the Northern Humboldt Current System. PLOS One. Available at http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0085919

Arancibia, H., & Neira, S. 2008. Overview of the Chilean hake (Merluccius gayi) stock, a biomass forecast, and the jumbo squid (Dosidicus gigas) predator-prey relationship off central Chile (33S-39S). CalCOFI Report, 49:104–115.

Arancibia, H., Barros, M., Neira, S., Markaida, U., Yamashiro, C., Icochea, L., … Kesternich, V. 2007. Análisis del impacto de la jibia en las pesquerías chilenas de peces demersales. Proyecto FIP N° 2005-38.

Aranda, M. 2009. Developments on fisheries management in Peru: The new individual vessel quota system for the anchoveta fishery. Fisheries Research, 96(2):308-312. doi:10.1016/j.fishres.2008.11.004

Argüelles, J. 2012. El calamar gigante Dosidicus gigas: Reproducción, alimentación y ciclo de vida. In Seminario "Biología, Producción y Comercialización de Jibia (Dosidicus gigas)." Valparaíso. Retrieved from http://www.subpesca.cl/prensa/601/w3-printer-60495.html

Argüelles, J., & Tafur, R. 2010. New insights on the biology of the jumbo squid Dosidicus gigas in the Northern Humboldt Current System: Size at maturity, somatic and reproductive investment. Fisheries Research, 106(2):185–192. doi:10.1016/j.fishres.2010.06.005

Argüelles, J., Csirke, J., Yamashiro, C., Mariategui, L. & Tafur, R. 2016. Notes on Research Needs and the Type and Level of Detail of the Data on Fishing Activities and Fishing Impacts to be Required from all Fleets Fishing for Jumbo Flying Squid (Dosidicus gigas) in the SPRFMO Convention Area. SPRFMO 4th Meeting of the Scientific Committee.

Argüelles, J., Rodhouse, P. G., Villegas, P., & Castillo, G. 2001. Age , growth and population structure of the jumbo flying squid Dosidicus gigas in Peruvian waters. Fisheries Research, 54:51–61.

Arkhipkin, Alexander I. , Paul G. K. Rodhouse, Graham J. Pierce, Warwick Sauer, et al 2015. Reviews in Fisheries Science & Aquaculture, 23:92–252, 2015 Available at http://www.tandfonline.com/doi/pdf/10.1080/23308249.2015.1026226

Arkhipkin, A.I., Rodhouse, P.G.K., Pierce, G.J., Sauer, W., Sakai, M., Allcock, L… Zeidberg, L. 2015. World Squid Fisheries. Reviews in Fisheries Science and Aquaculture, 23:92-252. doi:10.1080/23308249.2015.1026226

Arnould, J., Trinder, D., & McKinley, C. 2004. Interactions between fur seals and a squid jig fishery in southern Australia. Marine and Freshwater Research. Retrieved from http://www.publish.csiro.au/?paper=MF03030

Birdlife International. 2011. http://www.birdlife.org/action/science/species/seabirds/index.html

Blomeyer, R., Goulding, I., Pauly, D., Sanz, A. & Strobberup, K. 2012. The Role of China in World Fisheries. EU

Directorate-General for Internal Policies. 102 pp.

Boyle, P., & Rodhouse, P. 2005. Cephalopods: Ecology and Fisheries (pp. 262–263). Oxford, UK; Ames, Iowa: Blackwell.

Caddy, J. F., & Rodhouse, P. G. 1998. Cephalopod and Groundfish Landings: Evidence for Ecological Change in Global Fisheries? Reviews in Fish Biology and Fisheries, 8(4):431–444. doi:10.1023/A:1008807129366

Camhi, M.D., Valenti, S.V., Fordham, S.V., Fowler, S.L. and Gibson, C. 2009. The Conservation Status of Pelagic Sharks and Rays: Report of the IUCN Shark Specialist Group Pelagic Shark Red List Workshop. IUCN Species Survival Commission Shark Specialist Group. Newbury, UK. x + 78p

Carbajal Villalta, W. 2009. Bioecología y pesquería del recurso pota Dosidicus gigas en la costa norte del Perú. In Forum FIUPAP: Situación de la pesca artesanal en las regiones Piura-Tumbes. Retrieved from http://www.imarpe.gob.pe/paita/conferencias

CCT-PP. 2013. Reporte Técnico N°1 del Comité Científico Técnico de Pesquerías de Pequeños Pelágicos.

CCT-RDZCS. 2013. Acta Sesión N°02/2013 del Comité Científico Técnico de Recursos Demersales Zona Centro Sur.

CCT-RDZCS. 2014. Informe Técnico Sesiones 1 y 2 Comité Científico Técnico de Recursos Demersales de Zona Centro Sur.

CCT-RDZSA. 2013. Informe Técnico Primera Sesión Comité Científico Recursos Demersales de la Zona Sur-Austral. Primera Sesión.

CeDePesca. 2014a. Chilean Anchovy and Sardine Fishery Improvement Project.

CeDePesca. 2014b. Chilean Jack Mackerel CeDePesca Improvement Project.

CeDePesca. 2014c. Chilean Southern Hake Fishery Improvement Project. Retrieved from http://cedepesca.net/promes/whitefish/chilean-southern-hake/

Chen, Xinjun, Bilin Liu, Yong Chen 2008. A review of the development of Chinese distant-water squid jigging fisheries. Fisheries Research 89 (2008) 211–221

Chen, X., Lu, H., Liu, B. & Chen, Y. 2011. Age, growth and population structure of jumbo flying squid, Dosidicus gigas, based on statolith microstructure off the Exclusive Economic Zone of Chilean waters. J. Mar. Biol. Assoc. United Kingdom 91, 229–235.

Chen, X., Liu, B., & Chen, Y. 2008. A review of the development of Chinese distant-water squid jigging fisheries. Fisheries Research, 89(3):211–221. doi:10.1016/j.fishres.2007.10.012

Cheng, J., Cai, W., Cheung, W., Pitcher, T.J., Liu, Y, & Pramod, G. 2006. An Estimation of Compliance of the Fisheries of China with Article 7 (Fisheries Management) of the UN Code of Conduct for Responsible Fishing.

Chilvers, B. 2008. New Zealand sea lions Phocarctos hookeri and squid trawl fisheries: bycatch problems and management options. Endangered Species Research. Retrieved from http://www.int-res.com/articles/esr2008/theme/Bycatch/bycatchpp2.pdf

Cocas, L. 2014. Chilean Law 20.625 Regulating Discards at Sea: Its Implementation in National Fisheries. In 29th Lowell Wakefield Fisheries Symposium, "Fisheries Bycatch: Global Issues and Creative Solutions." Anchorage, May 13-16.

Cortés, A. 2012. Pescadores de jibia y su historia: Coquimbo-IV Región. In Seminario "Biología, Producción y Comercialización de Jibia (Dosidicus gigas)." Valparaíso. Retrieved from http://www.subpesca.cl/prensa/601/w3-printer-60495.html

Costello C., Gaines S. D., Lynham J. 2008. Can catch shares prevent fisheries collapse? Science 19 Septmber 2008: 321(5896), 1678-1681. [DOI:10.1126/science.1159478]

Estrella Arellano, C., & Swartzman, G. 2010. The Peruvian artisanal fishery: Changes in patterns and distribution over time. Fisheries Research, 101(3):133–145. doi:10.1016/j.fishres.2009.08.007

FAO. 2005. C. 2 World Squid Resources. In Review of the state of world marine fishery resources. Fisheries Technical Paper 457. Retrieved from http://www.fao.org/docrep/009/y5852e/y5852e00.htm

FAO. 2010b. Perfiles de Pesca y Acuicultura por Países. Chile. Departamento de Pesca Y Acuicultura de La FAO [en Línea].

FAO. 2010. Fishing Vessel Monitoring Systems. Peru - VMS programme. VMS Programme Factsheets. In: FAO Fisheries and Aquaculture Department. http://www.fao.org/fishery/topic/18089/en

FAO. 2014. The State of World Fisheries and Aquaculture. Retrieved from http://www.fao.org/3/a-i3720e.pdf

FAO. 2014. Fishery and Aquaculture Statistics. FishStatJ

FAO. 2016. The State of World Fisheries and Aquaculture: Contributing to food security and nutrition for all. 200 pp.

Field, J. C., Baltz, K. E. N., & Walker, W. A. 2007. Range expansion and trophic interactions of the jumbo squid, Dosidicus gigas, in the California Current. CalCOFI Report 48:131.

FIP. 2013. Memoria Año 2013, Fondo de Investigación Pesquera y Acuicultura.

FIP. 2015. Proyectos FIP. http://www.fip.cl/Proyectos.aspx

FishSource. 2015. <http://www.fishsource.com>

Francis, R. I. C. C. 1992. Use of Risk Analysis to Assess Fishery Management Strategies: A Case Study using Orange Roughy (Hoplostethus atlanticus) on the Chatham Rise, New Zealand. Canadian Journal of Fisheries and Aquatic Sciences, 49(5):922–930. doi:10.1139/f92-102

Froese, R. and D. Pauly (eds.). 2014. FishBase. World Wide Web electronic publication. www.fishbase.org, (11/2014)

Gelcich, S., Hughes, T. P., Olsson, P., Folke, C., Defeo, O., Fernández, M., … Castilla, J. C. 2010. Navigating transformations in governance of Chilean marine coastal resources. Proceedings of the National Academy of Sciences , 107(39):16794–16799. doi:10.1073/pnas.1012021107

Gilly, W., Markaida, U., Baxter, C., Block, B., Boustany, a, Zeidberg, L., … Salinas, C. 2006. Vertical and horizontal

migrations by the jumbo squid Dosidicus gigas revealed by electronic tagging. Marine Ecology Progress Series, 324:1–17. doi:10.3354/meps324001

Gilly, W. F., Beman, J. M., Litvin, S. Y., & Robison, B. H. 2013. Oceanographic and Biological Effects of Shoaling of the Oxygen Minimum Zone. Annual Review of Marine Science, 5(1):393–420. doi:10.1146/annurev-marine-120710-100849

High Seas Task Force (2006). Closing the net: Stopping illegal fishing on the high seas. Governments of Australia, Canada, Chile, Namibia, New Zealand, and the United Kingdom, WWF, IUCN and the Earth Institute at Columbia University

Ibáñez, C. M. 2013. El impacto ecológico del calamar Dosidicus gigas sobre poblaciones de merluzas en el Océano Pacífico. Amici Molluscarum, 21(1):7–16.

Ibáñez, C. M., Arancibia, H., & Cubillos, L. a. 2008. Biases in determining the diet of jumbo squid Dosidicus gigas (D' Orbigny 1835) (Cephalopoda: Ommastrephidae) off southern-central Chile (34°S–40°S). Helgoland Marine Research, 62(4):331–338. doi:10.1007/s10152-008-0120-0

Ibáñez, C., Cubillos, L.A., Tafur, R., Argüelles, J., Yamashiro, C., Poulin, E. 2011. Genetic diversity and demographic history of Dosidicus gigas (Cephalopoda: Ommastrephidae) in the Humboldt Current system. Mar. Ecol. Progr. Ser., 431:163-171.

IFOP. 2003. Evaluación del stock desovante de merluza del sur y merluza de cola en la zona sur-austral, año 2003. FIP 2003-09.

IFOP. 2013c. Investigación del estatus y posibilidades de explotación biológicamente sustentables en merluza de cola.

IFOP. 2013d. Investigación del estatus y posibilidades de explotación biológicamente sustentables en merluza del sur, año 2014.

IFOP. 2013f. Investigación del estatus y posibilidades de explotación sustentables en merluza de cola, año 2014. Convenio II: Estat.

IFOP. 2013e. Investigación del estatus y posibilidades de explotación sustentables en anchoveta centro-sur, año 2014. Anchoveta V-X Regiones 2014. Convenio II: Estatus y posibilidades de explotación biológicamente sustentables de los principales recursos pesqueros nacionales, año 2014.

IFOP. 2013a. Evaluación hidroacústica del stock desovante de merluza del sur y merluza de cola en la zona sur austral, año 2012. FIP 2012-07.

IFOP. 2013b. Investigación de estatus y posibilidades de explotación biológicamente sustentables en merluza de tres aletas, al sur del paralelo 47°S, año 2014. Convenio II: "Estatus y posibilidades de explotación biológicamente sustentables de los principales recursos.

IMARPE. 1995. Anuario Científico tecnológico.

IMARPE. 1996. Jumbo flying squid fishery in Peru. In International Symposium on Pelagic Large Squids. Tokyo.

IMARPE. 2001. Anuario Científico tecnológico.

IMARPE. 2005. Anuario Científico tecnológico.

IMARPE. 2008. Calamar Gigante. Retrieved from http://www.imarpe.pe/imarpe/index.php?id_detalle=00000000000000007846

IMARPE. 2009. Anuario Científico tecnológico.

IMARPE. 2010. Anuario Científico Tecnológico.

IMARPE. 2013a. Anuario Científico tecnológico.

IMARPE. 2013b. POI - PTI Evaluación Ejecutiva Anual del 2013.

IUCN Red List. 2014. http://www.iucnredlist.org

Kalikoski, D., Vasconcellos, M., & Pitcher, T. J. 2006. An Estimation of Compliance of the Fisheries of Peru with Article 7 (Fisheries Management) of the UN Code of Conduct for Responsible Fishing.

Kalikoski, D., Vasconcellos, M., & Pitcher, T. J. 2006b. An Estimation of Compliance of the Fisheries of Chile with Article 7 (Fisheries Management) of the UN Code of Conduct for Responsible Fishing.

Kelleher, K. 2005. Discards in the World's Marine Fisheries: An Update. FAO Fisheries Technical Paper 470.

Keyl, F., Argüelles, J., Mariátegui, L., Tafur, R., Wolff, M., & Yamashiro, C. 2008. A hypothesis on range expansion and spatio-temporal shifts in size-at-maturity of jumbo squid (Dosidicus gigas) in the eastern Pacific Ocean. CalCOFI Report, 49, 119–128.

Li, G., Chen, X., Zou, X. & Liu, B. 2016. National Report of China to the 2016 SPRFMO Science Committee Part II: the Squid Jigging Fishery. SPRFMO 4th Meeting of the Scientific Committee.

Li G, Chen X, Liu B, Xu L (2017) China's Annual Report to the 2017 SPRFMO Scientific Committee - Part II: the squid jigging fishery. Shanghai, China.

Liu, B., Chen, X. & Yi, Q. 2013. A comparison of fishery biology of jumbo flying squid, Dosidicus gigas outside three Exclusive Economic Zones in the Eastern Pacific Ocean. Chinese J. Oceanol. Limnol. 31, 523–533.

Liu, B., Chen, X., Fang, Z., Hu, S. & Song, Q. 2015. A preliminary analysis of trace-elemental signatures in statoliths of different spawning cohorts for Dosidicus gigas off EEZ waters of Chile. J. Ocean Univ. China 14, 1059–1067.

Liu, Bi Lin, Chen, Xin Jun, Li, Jian Hua, & Fang, Zhou. 2017. Statolith microstructure, age, and maturity of jumbo squid (Dosidicus gigas) in equatorial waters of the eastern tropical Pacific Ocean. Bulletin of Marine Science, 93(4). 943-957

Lizana, P. 2015. Chilean customs data for "Jibias," by exporter. Pers comm.

Mallory, T. G. 2012. China as a Distant Water Fishing Nation. Testimony to the Hearing on China's Global Quest for Resources and Implications for the United States.

Mallory, T. G. 2013. China's distant water fishing industry: Evolving policies and implications. Mar. Policy 38, 99–108.

Mariátegui, L., Tafur, R., Morón, O., and Ayon, P. 1997. Distribución captura del calamar gigante Dosidicus gigas a bordo de buques calamareros en aguas del Pacífico Centro Oriental y en aguas nacionales y adyacentes. Inf. Progr. Inst. Mar Perú, 63:3-36.

Markaida, U., & Sosa-Nishizaki, O. 2003. Food and feeding habits of jumbo squid Dosidicus gigas (Cephalopoda: Ommastrephidae) from the Gulf of California, Mexico. Journal of the Marine Biological Association of the UK, 83(3):507–522. doi:10.1017/S0025315403007434h

Morales-Bojórquez, E. & Pacheco-Bedoya, J. L. 2016. Jumbo Squid Dosidicus gigas: A New Fishery in Ecuador. Reviews in Fisheries Science & Aquaculture, 24(1). 98-110.

Morales-Bojórquez, E., Cisneros-Mata, M. A., Nevárez-Martínez, M. O., & Hernández-Herrera, A. 2001. Review of stock assessment and fishery biology of Dosidicus gigas in the Gulf of California, Mexico, 54:83–94.

MRAG. 2005. Review of impacts of illegal, unreported and unregulated fishing on developing countries. London. http://www.dfid.gov.uk/pubs/files/illega?l-fishing-mrag-report.pdf

Nelsen, A. 2013. Chile: Artisan Fishermen vs. Industrial Fishermen. The Pulitzer Center. June 20. Retrieved from http://pulitzercenter.org/reporting/chile-talcahuano-estrada-artisan-industry-fishermen-conflict-government-congress-small-scale-legal-battle-CONDEPP

National Fisheries Service. 2004. National Plan of Action Chile to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing. Retrieved from ftp://ftp.fao.org/Fi/DOCUMENT/IPOAS/national/chile/iuu.pdf

Nigmatullin, C. M., & Markaida, U. 2008. Oocyte development, fecundity and spawning strategy of large sized jumbo squid Dosidicus gigas (Oegopsida: Ommastrephinae). Journal of the Marine Biological Association of the United Kingdom, 89(4):789. doi:10.1017/S0025315408002853

Nigmatullin, C. M., Nesis, K. N., & Arkhipkin, A. I. 2001. A review of the biology of the jumbo squid Dosidicus gigas (Cephalopoda: Ommastrephidae). Fisheries Research, 54, 9–19.

NMFS. 2014. National Marine Fisheries Service, Office of Science and Technology, U.S. Foreign Trade Statistics. Available at: http://www.st.nmfs.noaa.gov/st1/trade/

OECD. 2009. An Appraisal of the Chilean Fisheries Sector.

Pauly, D., Belhabib, D., Blomeyer, R., Cheung, W. W. W. L., Cisneros-Montemayor, A. M., Copeland, D., … Zeller, D. 2013. China's distant-water fisheries in the 21st century. Fish and Fisheries, n/a–n/a. doi:10.1111/faf.12032

Pérez, A., Cortés, C., & Buschmann, A. H. 2005. Oceana. Bycatch en Chile: "Amenaza a la biodiversidad marina."

Pierce, G. J., & Guerra, A. 1994. Stock assessment methods used for cephalopod fisheries. Fisheries Research, 21, 255–285.

Pitcher, T. J., Kalikoski, D., Short, K., Varkey, D., & Pramod, G. 2009. An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries. Marine Policy, 33(2), 223–232. doi:http://dx.doi.org/10.1016/j.marpol.2008.06.002

Pompa, S., Ehrlich, P. R., & Ceballos, G. 2011. Global distribution and conservation of marine mammals. Proceedings of the National Academy of Sciences of the United States of America, 108(33):13600–5.

doi:10.1073/pnas.1101525108

Pramod, G., Nakamura, K., Pitcher, T. J., & Delagran, L. 2014. Estimates of illegal and unreported fish in seafood imports to the USA. Marine Policy, 48(0):102–113. doi:http://dx.doi.org/10.1016/j.marpol.2014.03.019

Probst WN, Oesterwind D (2014) How good are alternative indicators for spawning-stock biomass (SSB) and fishing mortality (F)? ICES Journal of Marine Science, 71, 1137–1141.

PRODUCE. 2001. Resolución Ministerial No 415-2001-PE. Aprueban el Programa de "Implementación de un Sistema de Captación de Datos sobre el Desembarque de la Pesca Artesanal."

PRODUCE. 2011. Decreto Supremo No 014-2011-PRODUCE. Reglamento del ordenamiento pesquero del calamar gigante o pota (Dosidicus gigas).

PRODUCE. 2012a. Decreto Supremo No. 008-2012-PRODUCE. Decreto Supremo que establece medidas para la conservación del recurso hidrobiológico. Retrieved from http://www2.produce.gob.pe/dispositivos/publicaciones/2012/ds008-2012-produce.pdf

PRODUCE. 2012b. Resolución Ministerial No. 036-2012-PRODUCE. Retrieved from http://www2.produce.gob.pe/dispositivos/publicaciones/2012/enero/rm036-2012-produce.pdf

PRODUCE. 2012d. Resolución Ministerial No. 036-2012-PRODUCE. "Establecer una cuota de captura del recurso calamar gigante o pota (Dosidicus gigas), de 500 mil toneladas para el año 2012."

PRODUCE. 2014. Decreto Ley No 25977 - Ley General de Pesca. http://www.produce.gob.pe/index.php/ley-general-de-pesca

Rocha, F., & Vega, M. 2003. Overview of cephalopod fisheries in Chilean waters. Fisheries Research, 60(1):151–159. doi:10.1016/S0165-7836(02)00080-2

Rodhouse, P. G. 2001. Managing and forecasting squid fisheries in variable environments. Fisheries Research, 54, 3–8.

Rodhouse, Paul G.K., Graham J. Pierce, Owen C. Nichols, Warwick H.H. Sauer, Alexander I. Arkhipkin, Vladimir V. Laptikhovsky, Marek R. Lipinski, Jorge E. Ramos, Michaël Gras, Hideaki Kidokoro, Kazuhiro Sadayasu, João Pereira, Evgenia Lefkaditou, Cristina Pita, Maria Gasalla, Manuel Haimovici, Mitsuo Sakai and Nicola Downey. Environmental Effects on Cephalopod Population Dynamics: Implications for Management of Fisheries. In Erica A.G. Vidal, editor: Advances in Marine Biology, Vol. 67, Oxford: United Kingdom, 2014, pp. 99-233. Available at http://www.researchgate.net/publication/262812266_Environmental_Effects_on_Cephalopod_Population_Dynami

Rosa, Rui, Carmen Yamashiro, Unai Markaida, Paul G. K. Rodhouse, Claire M. Waluda, César A. Salinas-Zavala, Friedemann Keyl, Ron O´Dor, Julia S. Stewart and William F. Gilly 2013. Chapter 6 - Dosidicus gigas, Humboldt squid. In Rosa, Rui, Ron O'Dor and Graham Pierce (eds.) 2013. Advances in Squid Biology, Ecology and Fisheries. Part II – Oegopsid Squids, pp 19-206

San Martín, G., Parma, A.M., Orensanz, J.M. 2010. "The Chilean Experience with Territorial Use Rights in Fisheries," in Handbook of Marine Fisheries Conservation and Management, ed. Grafton, R.Q., Hilborn, R., Squires, D., Tait, M., Williams, M. Oxford University Press.

Sandoval-Castellanos, E., Uribe-Alcocer, M. and Díaz-Jaimes, P. 2010. Population genetic structure of the Humboldt squid (Dosidicus gigas d'Orbigny, 1835) inferred by mitochondrial DNA analysis. J. Exp. Mar. Bio. Ecol.

385, 73–78.

Sandoval-Castellanos, E., Uribe-Alcoce, M., Diaz-Jaimes, P. 2007. Population genetic structure of jumbo squid (Dosidicus gigas) evaluated by RAPD analysis. Fisheries Research, 83:113-118.

Sernapesca. 2013. Informe: Actividades de fiscalización efectuadas en materia de pesca y acuicultura en el año 2012.
http://www.sernapesca.cl/presentaciones/Informe_Final_Rendicion_de_Cuentas_2012_Art_4_B_LGPA_SERNAPE

Informe: Actividades de fiscalización efectuadas en materia de pesca y acuicultura en el año 2012.
http://www.sernapesca.cl/presentaciones/Informe_Final_Rendicion_de_Cuentas_2012_Art_4_B_LGPA_SERNAPE

Sernapesca. 2014. Anuario 2013 - Desembarque Total Región. Retrieved from
http://www.sernapesca.cl/index.php?option=com_remository&Itemid=246&func=fileinfo&id=8822

Sustainable Fisheries Partnership. 2014. Chilean Hoki Fishery Improvement Project.
https://www.sustainablefish.org/fisheries-improvement/whitefish/chilean-hoki

SPRFMO. 2013a. 2013 National Report of Chinese Taipei to SPRFMO Scientific Committee on the Squid Jigging Fishery in the Southeast Pacific Ocean. In 1st Meeting of the Scientific Committee (pp. 21–27). La Jolla.

SPRFMO. 2013b. CMM 2.01 Conservation and Management Measure for Trachurus murphyi (Annex G) (Vol. 20).

Staaf, D. J., Camarillo-Coop, S., Haddock, S. H. D., Nyack, A. C., Payne, J., Salinas-Zavala, C. a., … Gilly, W. F. 2008. Natural egg mass deposition by the Humboldt squid (Dosidicus gigas) in the Gulf of California and characteristics of hatchlings and paralarvae. Journal of the Marine Biological Association of the UK, 88(04):759–770. doi:10.1017/S0025315408001422

Staaf, D. J., Ruiz-Cooley, R.I., Elliger, C., Lebaric, Z., Campos, B., Markaida, U., Gilly, W. 2010. Ommastrephid squids Sthenoteuthis oualaniensis and Dosidicus gigas in the eastern Pacific show convergent biogeographic breaks but contrasting population structures. Mar. Ecol. Prog. Ser. 418:165-178.

Stewart, I. J., & Hanselman, D. H. 2012. Chilean Hoki stock assessment review 2012. CHOSAR2012 Review Report. Instituto de Fomento Pesquero/División Investigación Pesquera (Vol. 1, pp. 1–36).

Stewart JS, Hazen EL, Foley DG, Bograd SJ, Gilly WF (2012) Marine predator migration during range expansion: Humboldt squid Dosidicus gigas in the northern California Current System. Mar Ecol Prog Ser 471:135-150.

Stop Illegal Fishing, Trygg Mat Tracking and NFDS (2017) Squid capture in the Northwest Indian Ocean: unregulated fishing on the high seas. Gaborone, Botswana

Subpesca. 2012a. Cuota Global Anual de Captura de Jibia (Dosidicus gigas) XV-XII Regiones, Año 2013. Informe Técnico (R. Pesq.) N° 239/2012.

Subpesca. 2012b. Cuota global anual de captura para las unidades pesquería de anchoveta (Engraulis ringens) y sardina común (Strangomera bentincki) V a X Regiones, año 2013. Informe Técnico (R. Pesq.) N°210/12.

Subpesca. 2012c. Informe Técnico (R. Pesq.) No. 216-12. Cuota global anual de captura de merluza del sur (Merluccius australis), año 2013.

Subpesca. 2013a. Cuota Global Anual de Captura de Jibia (Dosidicus gigas) XV-XII Regiones, Año 2014. Informe

Técnico (R. Pesq.) N° 213/2013.

Subpesca. 2013b. Cuota global anual de captura de merluza de tres aletas (Micromesistius australis), año 2014. Informe Técnico (R. Pesq.) N° 221/2013.

Subpesca. 2013c. Decreto Exento No. 1409. Establece cuotas anuales de captura de unidades de pesquería de recursos pelágicos pequeños que indica sometidas a licencias transables a pesca, año 2014.

Subpesca. 2013e. Dto. Exento No. 1410. Establece cuotas anuales de captura para unidades de pesquería de recursos demersales que indica sometidas a licencias transables de pesca, año 2014.

Subpesca. 2013f. Fraccionamiento y distribución de la cuota global anual de captura anchoveta y sardina común, Regiones V a X, año 2014. Informe Técnico (R. Pesq.) N°193-13.

Subpesca. 2013g. Fraccionamiento y distribución de la cuota global de captura de jurel para las unidades de pesquería de la XV-II, III-IV, V-IX y XIV-X Regiones, año 2014. Informe Técnico (R. Pesq.) N° 211-2013.

Subpesca. 2013h. Fraccionamiento y distribución de la cuota global de captura, anchoveta y sardina española Regiones III y IV, año 2014. Informe Técnico (R. Pesq.) N° 191-13.

Subpesca. 2013i. Fraccionamiento y distribución de la cuota global de captura, anchoveta y sardina española Regiones XV, I y II, año 2014. Informe Técnico (R. Pesq.) N° 191-13.

Subpesca. 2013j. Listado de Fauna Acompañante de Pesquerías sometidas a LTP, conforme LGPA. Informe Técnico (SAP) N°140.

Subpesca. 2013k. Política de Descarte Pesquero en Chile. Boletín Informativo. http://www.subpesca.cl/prensa/601/articles-81487_recurso_1.pdf

Subpesca. 2012d. Define el descarte de especies hidrobiológicas y establece medidas de control y sanciones para quienes incurran en esta práctica en las faenas de pesca. Ley No. 20.625

Subpesca. 2014a. Decreto Exento No. 22. Establece cuota anual de captura para el recurso jibia XV-XII regiones, año 2014.

Subpesca. 2014b. Decreto Exento No. 417. Establece fraccionamiento de la cuota anual de captura para el recurso jibia XV-XII regiones, período 2014-2019.

Subpesca. 2014c. Memorandum Técnico (R. Pesq.) No. 016-2014. Corrección al fraccionamiento sectorial cuota anual jibia 2014.

Subpesca. 2014d. Nueva Ley de Pesca y Acuicultura No. 20.657. Retrieved from http://www.subpesca.cl/prensa/601/w3-propertyvalue-2832.html

Subpesca. 2014e. Suspende transitoriamente la inscripción en el registro artesanal en la pesquería que indica por período que señala. Res. Ex. No. 3421

Subpesca, 2015. "Especies hidrobiológicas." http://www.subpesca.cl/institucional/602/w3-propertyname-510.html

Subsecretario de Recursos Pesqueros. 2014. Acuerdo N°080. Autorizar la pesquería de Calamar Gigante

(Dosidicus gigas) y emitir las medidas de ordenamiento, regulación, y control sobre su captura.

UNDP. 2015. "Towards Ecosystem-Based Management of the Humboldt Current Large Marine Ecosystem" http://www.eeg-regionalcentrelac-undp.org/index.php?option=com_content&view=article&id=112%3Agestion-basada-en-el-gran-ecosistema-marino-de-la-corriente-de-humboldt&catid=24%3Anuestras-historias&Itemid=5&lang=en

Waluda, C. M., Yamashiro, C., & Rodhouse, P. G. 2006. Influence of the ENSO cycle on the light-fishery for Dosidicus gigas in the Peru Current: An analysis of remotely sensed data. Fisheries Research, 79(1-2):56–63. doi:10.1016/j.fishres.2006.02.017

Xu, L., Li, B., Chen, Y., Chen, X. & Li, G. 2016. An Assessment of the D. gigas fishery in South-east Pacific Ocean using a State-space Surplus Production model. SPRFMO 4th Meeting of the Scientific Committee.

Xu L, Li B, Li G, Chen X, Chen Y (2017) A Stock assessment of the jumbo flying squid (Dosidicus gigas) in Southeast Pacific Ocean. SPRFMO 5th Meeting of the Scientific Committee. Shanghai, China.

Xu, L., Li, B., Li, G., Chen, X. & Y. Chen. 2017. A Stock assessment of the jumbo flying squid (Dosidicus gigas) in Southeast Pacific Ocean (2017). 5th Meeting of the Scientific Committee, Shanghai, China 23 - 28 September 2017. SC5-SQ02. Available at: https://www.sprfmo.int/assets/00-SC5-2017/SC5-SQ02-Stock-assessment-for-jumbo-flying-squid-in-SE-Pacific-2017.pdf

Xue, G. (Julia). 2006. China's distant water fisheries and its response to flag state responsibilities. Mar. Policy 30, 651–658.

Yu, W. and Xinjun Chen. 2018. Ocean warming-induced range-shifting of potential habitat for jumbo flying squid Dosidicus gigas in the Southeast Pacific Ocean off Peru. Fisheries Research 204 (2018) 137–146.

Yu, W., Yi, Q., Chen, X., and Yong Chen. 2016. Modelling the effects of climate variability on habitat suitability of jumbo flying squid, Dosidicus gigas , in the Southeast Pacific Ocean off Peru. ICES Journal of Marine Science, Volume 73, Issue 2, 1 February 2016, Pages 239–249. Accessed at:https://academic.oup.com/icesjms/article/73/2/239/2614468#

Yu, W., Yi, Q., Chen, X., and Yong Chen. 2017. Climate-driven latitudinal shift in fishing ground of jumbo flying squid (Dosidicus gigas) in the Southeast Pacific Ocean off Peru. International Journal of Remote Sensing. VOL. 38, NO. 12, 3531–3550, 2017.

Zeidberg, L. D., & Robison, B. H. 2007. Invasive range expansion by the Humboldt squid, Dosidicus gigas, in the eastern North Pacific. Proceedings of the National Academy of Sciences of the United States of America, 104(31):12948–50. doi:10.1073/pnas.0702043104

Zuleta, A. 2004. The management of small pelagic fisheries in Chile. FAO Fisheries Report 700. Rome, Italy.