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**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**

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# **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**

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## **SUMMARY**

The few partial assessments of the stock(s) of jumbo flying squid (*Dosidicus gigas*) in the Southeast Pacific available suggest that although catches are fairly high and increasing, the stock or stocks are in a healthy situation and there might even be some room for a further increase in catches as long as current conditions favorable for jumbo flying squid will persist. However, past experiences indicate that this may change on short notice and that timely actions may be required in light of the high fishing capacity deployed and the high variability in abundance typical of squids and other short-lived species. Therefore, the SPRFMO should not wait for the stock or stocks to be in critical condition or have their sustainable use being hampered to implement adequate databases and develop and start applying appropriate stock assessment and fishery monitoring tools and procedures, which would facilitate the provision of timely advice and the eventual adoption of the management measures that may be deemed necessary to ensure the conservation and sustainability of this important fishery resource. The medium and long term research priorities identified in the SC Research Programme 2013 adopted by the Scientific Committee (SC) at its first meeting in La Jolla, U.S.A., 21-27 October 2013, should serve as a basis for defining the type and level of detail of the jumbo flying squid data that fishing parties may be required to provide to the SPRFMO Secretariat on a regular basis for regular reporting, monitoring and stock assessment purposes. To a great extent the level of detail of the required data is already defined in the existing templates for reporting on the catch per tow for trawlers and per drift set for jiggers, which includes full details of the vessel and gears used, the location and duration of each tow or drift set, the target species and the live weight of each species in the total catch, per tow or drift set. Once available, this data can be easily processed by the Secretariat to provide daily, weekly, monthly, seasonal and/or yearly summaries for using as input for the selected stock assessment method(s). In addition, some of the stock assessment methods to be applied would require biological data, such as length-frequency distributions, weight at length, sex composition and sexual maturity, which may need to be collected by onboard observers covering the whole fleet and catches of jumbo flying squid, either directly or through a proper sampling scheme. A recommendation is therefore made to use the templates already available to enforce the reporting on the fishing activities of trawlers and jiggers participating in the jumbo flying squid fishery in the Convention area; invite parties to provide the same type of templates for their past fishing activities, if available; and plan for the sooner implementation in the jumbo squid fishery of an Observer Programme similar to the one already existing for vessels participating in the fishery.

## 1. INTRODUCTION

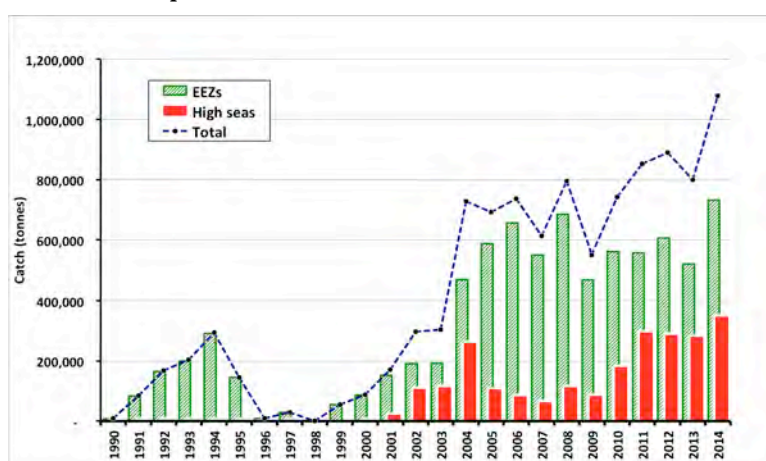
This report is presented in partial fulfillment of one of the tasks in the Scientific Committee Work Plan for 2016 adopted by the 4<sup>th</sup> meeting of the Commission of the South Pacific Regional Fisheries Management Organisation (SPRFMO), held in Valdivia, Chile, 22-29 January 2016, which invites Peru and others to provide papers to guide the consideration by the Scientific Committee (SC) of the issue of the level of detail required for the data on fishing activities and the impacts of fishing to be provided to the SPRFMO Secretariat to facilitate effective stock assessment of the jumbo flying squid (*Dosidicus gigas*).

On this we would like to note that it is generally agreed that all those fishing for jumbo flying squid in the SPRFMO Convention area should comply with SPRFMO Conservation and Management Measure on Standards for the Collection, Reporting, Verification and Exchange of Data (CMM 3.02), including those sections that apply to the provision of data for stock assessment and monitoring of the jumbo flying squid fishery. However, there have been delays in the implementation of substantial parts of CMM 3.02 in the jumbo flying squid fishery pending some questionings and requests for clarification regarding paragraph 1(e) in CMM 3.02 on what would be the “sufficient detail” of the data to be provided to the SPRFMO Secretariat to facilitate the effective stock assessment of jumbo flying squid. It is expected that with this and other contributions the upcoming 4<sup>th</sup> meeting of the Scientific Committee (SC-04) would be able to clarify this issue and provide unequivocal guidance on the minimum and desirable requirements for the jumbo flying squid data to be provided to the SPRFMO Secretariat in compliance with paragraph 1(e) and other relevant sections of CMM 3.02.

### 1.1. The jumbo flying squid fishery

Jumbo flying squid (*Dosidicus gigas*) is the largest and most abundant Ommastrephidae in the Eastern Pacific and sustains important coastal and high seas fisheries in the Southeast Pacific (FAO Area 87), concerning both the eastern part of the SPRFMO Convention area and the jurisdictional waters of the coastal States in the area, particularly Peru and Chile where important coastal fisheries for this species have developed in recent years.

Some exploratory fishing for jumbo flying squid was carried out in the high seas of the Southeast Pacific in the mid-1980s by Japan. Commercial fishing operations for this species only started in the 1990s, mostly within Peruvian jurisdictional waters. There was a first period of high catches that peaked at 294,000 t in 1994 and after a brief low period total catches of jumbo flying squid have increased steadily, mainly within jurisdictional waters but also in the high seas (Figure 1). The total catch of jumbo flying squid in the whole Southeast Pacific reached a record high of 1,078,000 tonnes (t) in 2014. Most of it (68%) was



**Figure 1. Annual catches of jumbo flying squid (*Dosidicus gigas*) in jurisdictional waters and in the high seas in the Southeast Pacific, years 1990-2014 (Source: SPRFMO data)**

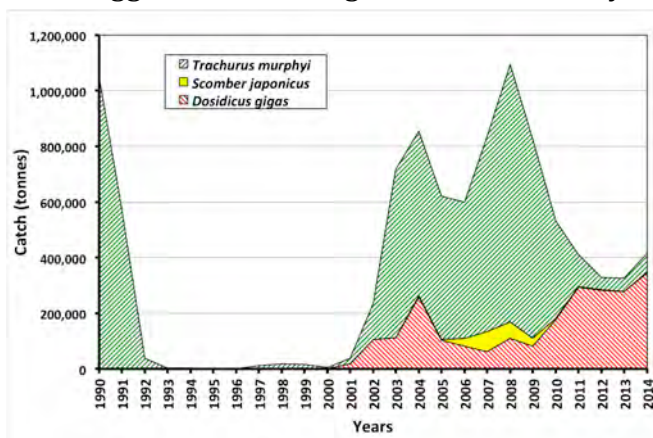
caught within the jurisdictional waters of Peru and Chile by their own local, mostly artisanal fleets. However, the total amount and share of jumbo flying squid being caught in the adjacent high seas within the area of application of the SPRFMO Convention has been rising steadily, from 61,000 t (10%) in 2007 to 346,000 t (32%) in 2014.

## 2. NEED FOR MONITORING AND ASSESSMENT

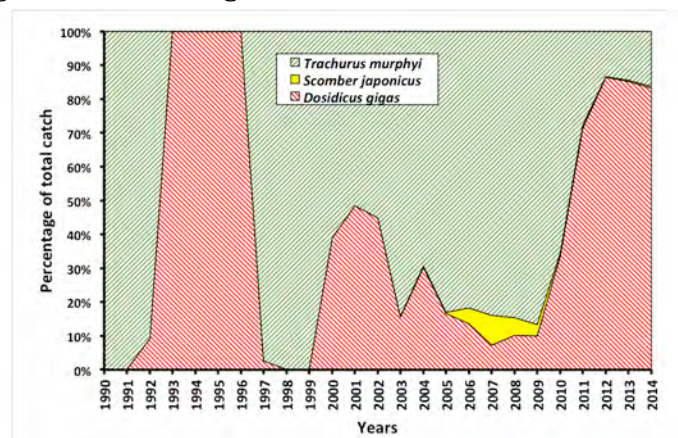
The main exploited transboundary species of concern when the Convention on the Conservation and Management of High Seas Fishery Resources in the South Pacific Ocean was adopted and the SPRFMO was established were jack mackerel (*Trachurus murphyi*) in the eastern South Pacific and orange roughy (*Hoplostethus atlanticus*) and other deepwater species in the western South Pacific. The stocks of these species were assessed as being in critical situation when the consultation process that led to the adoption of the Convention and the establishment of the SPRFMO initiated in 2006, and rightly so this motivated the application of restrictive fisheries management measures addressing the situation of jack mackerel and deepwater species as a matter of utmost priority upon the adoption of the Convention in 2010.

For several years after the inception of the SPRFMO, it was jack mackerel the species that sustained the most important fishery and has produced the highest catches in the eastern part of the SPRFMO Convention area, but in recent years jumbo flying squid has been taking over. While catches of jack mackerel have been decreasing consistently, mostly due to its reduced abundance and the stringent fisheries management regulations being imposed, total catches of jumbo flying squid have been on the rise. The total catch of jack mackerel and its percentage contribution to the total catch in the eastern part of the SPRFMO Convention area have declined dramatically, from a maximum of 927,000 t (85%) in 2008 to 68,000 t (16%) in 2014. While in the same period the total catch of jumbo flying squid and its percentage contribution to the total catch in the same area has increased from 111,000 t (10%) in 2008 to 346,000 t (83%) in 2014 (Figures 2 and 3), leaving no doubts on the current and future importance of this fishery in the context of the SPRFMO.

The few partial assessments of the stock(s) of jumbo flying squid in the Southeast Pacific that were presented during the 4<sup>th</sup> meeting of the Scientific Committee (SC-04) in 2015 suggest that although catches are fairly high and increasing, the stock or stocks are in a



**Figure 2. Catch composition of the main species fished in the eastern side of the SPRFMO Convention area (FAO Area 87), in tonnes, years 1990-2014**



**Figure 3. Catch composition of the main species fished in the eastern side of the SPRFMO Convention area (FAO Area 87), weight in %, years 1990-2014**

healthy situation and there might even be some room for a further increase in catches as long as the current environmental conditions that seem to be favorable for jumbo flying squid will persist. From this some may conclude that for the time being there would not be much need or support for the adoption of fisheries management measures to regulate the jumbo flying squid fishery in the Convention area. However, one may argue that as stated in its Article 2, the one main objective of the SPRFMO Convention is to “*through the application of the precautionary approach [...] ensure the long-term conservation and sustainable use of fishery resources*”. Moreover, it should not be given for granted that the favorable conditions for jumbo flying squid that we have been observing in the last few years will last forever and some preparedness to deal with more critical conditions of reduced abundance and fishing constrains should be built within the SPRFMO.

Therefore, the SPRFMO should not wait for the stock or stocks (of jumbo flying squid in this case) to be in critical condition or to have their sustainable use hampered to implement an adequate database and develop and start applying appropriate stock assessment and fishery monitoring tools and procedures. Which would facilitate the timely advice and eventual adoption of the management measures that may be deemed necessary to ensure the conservation and sustainability of this important fishery resource, shall there be a change in the current favorable conditions for jumbo flying squid. This is of primary importance, especially considering that jumbo flying squid is now sustaining important fisheries both in the Convention area and in the jurisdictional waters of coastal member States such as Peru, Chile, and to some extent, also Ecuador. Where there are now well-established local fisheries, mostly operating with artisanal or small-scale boats that involve the participation of large numbers of local fishermen that depend heavily for their wellbeing on the conservation and sustainability of the jumbo flying squid stock(s) in the Southeast Pacific.

### **3. RESEARCH PRIORITIES**

To define the type and level of detail of the jumbo flying squid data that parties may be required to provide to the SPRFMO Secretariat on a regular basis we may wish to recall the SPRFMO medium and long term research priorities for jumbo flying squid identified in the Draft Research Programme prepared during the 11<sup>th</sup> meeting of the Science Working Group (SWG-11) of the SPRFMO held in Lima, Peru, 15-19 October 2012, and in its update adopted by the 1<sup>st</sup> meeting of the Scientific Committee (SC-01) held in La Jolla, U.S.A., 21-27 October 2013, which was published as the SC Research Programme 2013 in Annex 6 of its final report. In addition, we may also wish to consider the short term priorities regarding jumbo flying squid research that were agreed by the 3<sup>rd</sup> meeting of the Scientific Committee (SC-03) held in Port Vila, Vanuatu, 28 September – 3 October 2015.

The Research Programme 2013 in Annex 6 of the SC-01 report highlights main medium and long term research priorities for the SPRFMO and with regards to jumbo flying squid it already addressed some of the key data requirements and provided some indications of the desired spatial and/or temporal resolution level or level of detail of some of this data. However, the SC-02 meeting in 2014 didn't pay much attention to squids, but this oversight was somehow corrected during the SC-03 meeting in 2015. Where more time and attention was devoted to jumbo flying squid, as attested by the seven technical reports with information relevant to jumbo flying squid that were tabled and discussed during the meeting and the extent and intent of the conclusions and recommendations in

the SC-03 meeting report. The SC-03 meeting also examined the medium and long-term priorities in its 2013 Research Programme and identified the following four short-term priorities regarding its future research work on squids:

- (a) To promote research on the effects that the depletion by fishing of potential predators of the different life-history stages of jumbo flying squid may have in favoring the growth and expansion of jumbo flying squid.
- (b) To promote research on the population structure and the presence and distribution of strains, groups or population subunits of jumbo flying squid and their migration routes and intermix patterns throughout the Southeast Pacific.
- (c) To promote research on the reproductive process and the effect of environmental factors in determining the timing and the location and extension of spawning areas.
- (d) To promote or undertake research to obtain early estimations of recruitment and timely assessment of escapement.

It was and it is still is hoped that by highlighting these four short-term priorities the SC-03 will contribute to mobilize more substantive work on jumbo flying squid. However, it is also noted that in listing the above short-term priorities the SC-03 failed to specify or elaborate further on the type, coverage and resolution level or level of detail of the data required to fulfill these priorities and to ensure compliance with CMM 3.02.

It is also noted that except for part of priority (d) above regarding the undertaking of research to obtain early estimations of recruitment and timely assessment of escapement, most of these short-term priorities refer to, or call for research efforts to be undertaken by the parties, possibly with the encouragement and some guidance from the SPRFMO or its Scientific Committee but not necessarily under the direct responsibility, supervision or leadership of the SPRFMO (through its Secretariat or its Scientific Committee).

Nevertheless, in a clear reference to the requirements in CMM 3.02 the Scientific Committee included in its SC-03 meeting report some specific recommendations for the Commission to:

- (i) Implement monitoring and reporting procedures on jumbo flying squid research and fishing activities in the Convention area; and,
- (ii) Engage in the development of science and management tools that will contribute to ensure the long-term sustainability of the jumbo flying squid stock and fisheries.

It was expected that if adopted, these recommendations would have contributed to the full implementation of CMM 3.02 with respect to jumbo flying squid. But unfortunately these recommendations bounced back with the request from the 4<sup>th</sup> meeting of the Commission for the SC to consider and advise on the level of detail for the data on jumbo flying squid to be required in relation to CMM 3.02 paragraph 1(e). Therefore, the full implementation of CMM 3.02 with regards to jumbo flying squid still lags behind pending the unraveling of the issue of the level of detail of the data to be provided to the Secretariat in compliance with this CMM.

However, as pointed above, it is our view that further delays in the implementation of proper reporting and monitoring procedures for the jumbo flying squid stock(s) and fisheries in the Convention area should not be acceptable, and in our intent to assist the

SC-04 in tackling this issue in the best proper manner we are providing below some notes on the desirable and the minimum spatial and temporal resolution (level of detail) of the data from the jumbo flying squid fishery in the Convention area that should be provided regularly to the SPRFMO Secretariat in compliance with CMM 3.02.

#### 4. DATA REQUIREMENTS

In considering the various research priorities we will first build on the tasks to be developed already identified by the SC in its Research Programme 2013, selecting and trying to specify and/or expand whenever needed on what is already there in relation to the data that would be required for the Secretariat and/or the Scientific Committee to implement its reporting, monitoring and assessment duties with regards to jumbo flying squid. This will be then complemented with a brief review of the main stock assessment methods applicable to squids that might be worth considering for future use by the Scientific Committee and which would justify the early establishment of appropriate databases.

##### 4.1 Data requirements for fisheries monitoring and reporting by the Secretariat

The SPRFMO Secretariat should be able to monitor and report on the progress of all squid directed fishing activities and all directed and incidental catches of jumbo flying squid (*D. gigas*) in the Convention area, with the possibility of registering and also reporting on the incidence of other species of squid signaled as of potential interest within the SPRFMO Convention area, such as purple-back flying squid (*Sthenoteuthis oualaniensis*) and neon flying squid (*Ommastrephes bartrami*). Therefore, all parties fishing for jumbo flying squid in the Convention area should collect and provide to the Secretariat general catch and effort data and biological data at the level of detail indicated below:

- **Catch data** - this should be provided for the entire fleet as live weight in tonnes by species, fishing area grouped by FAO area and by type of sea (high sea or EEZ) and type of fleet or fishing gear used, by month and by calendar year. The monthly squid catch data should be submitted following similar procedures and using a similar data submission template as the one currently used for reporting the *Trachurus murphyi* monthly catch data (ref.: template "*CMM 2.01; Monthly Report (CJM) 2014\_v3.docx*"), which would require only slight modifications to be usable for *Dosidicus gigas*. The squid catch data by calendar year is already being submitted by all parties concerned through the existing template (ref.: template "*Annual-Catch-Data-Template-Direct.xls*") that covers the annual catch data for all species.
- **Fishing effort or fishing activity data** - this should be provided for the entire fleet at the level of detail of each individual tow (for trawl) or drift set (for jigging) using the existing trawl and squid jigging fishing activity templates (ref.: templates "*FishingactivitytemplateTrawl-Rev4-Direct.xls*" & "*FishingactivitytemplateSquidJigging-Rev4-Direct.xls*"), where for each tow or drift set the reporting party clearly identifies the vessel by name, call sign, IMO number, etc., followed by information on the starting date and time, starting position, ending position and total duration of the individual tow or drift set, the intended target species, details on the crew, fishing gear, auxiliary equipment, observations of marine mammals, seabirds and reptiles, and total catch as live weight and species composition of the catch retained and discarded. The Secretariat will process this detailed data to produce accumulated monthly and yearly reports on catch totals and by species and of total fishing effort or fishing activities

(e.g. as number of vessels-days) by participating party and fleet or gear type. As explained below, more detailed higher resolution information could be derived from the same data sets for the purposes of stock assessment and monitoring by the Scientific Committee. And any confidentiality concerns arising from the refined level of detail (e.g. in the case of individual boats operating far apart from the rest of the fleet for protracted periods of time) could be addressed with the Secretariat to proceed with some ad-hoc lumping of the data when preparing summary reports.

- **Biological data** – provisions should be made to allow for the proper identification and recording onboard the entire fleet of the species composition (live weight in kg.) of the catch retained and discarded per tow or drift set, as well as for recording the presence/absence of marine mammals, seabirds and reptiles. As explained below, additional information and data would be required for the purposes of stock assessment and monitoring by the Scientific Committee.

#### **4.2 Data requirements for stock assessment and monitoring by the Scientific Committee**

Besides the data to be provided to the SPRFMO Secretariat for its regular monitoring and monthly and yearly reporting, it is anticipated that the Scientific Committee would require more detailed higher resolution data which in some cases could be fulfilled through the existing templates mentioned above, but in other cases may require the use of additional or modified templates and the presence of onboard observers. These requirements of additional data are intended to satisfy scientific research needs to allow the Scientific Committee to regularly assess and monitor the potential and state of exploitation of the jumbo flying squid stock or stocks, and thus provide appropriate and timely advice to the Commission of the SPRFMO on possible fisheries management options if/as needed.

Satisfying these research needs requires improving understanding of the biology and population dynamics of jumbo flying squid (*D. gigas*) as a matter of first priority (...to be extended to the other two squid species if/as feasible). This should include improving information and estimates on age and growth, mortality, migrations (e.g.: daily, seasonal, reproductive), sexual development and reproduction, spawning areas and timing, recruitment success and abundance, trophic interactions and stock structure and distribution. In addition, the SPRFMO squid databases should provide the foundations for the application of adequate stock assessment methods.

The type and level of detail of the data for stock assessment and monitoring may vary according to the method or methods to be used, ...and its readily availability can also determine which methods could be used. Any limitation on the time and space coverage of the data or on its level of detail would limit the type, relevance and precision of the stock assessment methods which could be applied, and it is clear that in the case of the jumbo flying squid all efforts should be made to maintain these options as open as possible without causing an excessive burden at the data collection end onboard fishing vessels.

Table 1 provides a brief summary of the type, level of detail and coverage of the fishery dependent data that would be required to facilitate the application of selected methods in the monitoring and assessment of the state of exploitation of jumbo flying squid (*Dosidicus gigas*) by the Scientific Committee of the SPRFMO. Only methods that provide



stock abundance and yield estimates relying mostly or entirely on the use of fisheries dependent data are being considered here. Therefore, stock research and assessment methods that rely on data or experimental work onboard research vessels or dedicated fishing vessels such as the acoustics and catch tag and release methods are not considered here.

To a great extent it is encouraging to note that all the data on catch, fishing activity or fishing effort and derived abundance indexes (CPUE) that can be required for any of the methods listed in Table 1 can be extracted with the required level of detail from the templates already available and being used or already agreed that should be used for the fisheries monitoring and reporting by the Secretariat. Their use would just need to be enforced and the data be processed differently by the Secretariat to ensure the more refined resolution level or level of detailed required for stock assessment purposes.

The existing trawl and squid jigging fishing activity templates (ref.: templates "*FishingactivitytemplateTrawl-Rev4-Direct.xls*" and "*FishingactivitytemplateSquidJigging-Rev4-Direct.xls*") would provide once enforced all the required data on catch per tow (for trawlers) or drift set (for jiggers) for the entire fleet. Including full details of the vessel and gears used, location and duration of each tow or drift set and target and captured species, which can be processed to provide daily, weekly, monthly, seasonal or yearly summaries for inputting into the selected stock assessment method(s).

In addition, some of the proposed methods would require biological data which in most cases needs to be gathered by onboard observers covering the whole fleet and catches, either directly or through a proper sampling scheme. The biological data to be collected from the fishery on a daily basis, to be weighted to the daily catch and processed or reported on a weekly and monthly basis are:

- (a) length-frequency distribution of catches, measured as dorsal mantle length (DML) to the nearest cm below,
- (b) weight at length (in g and cm) of specimens caught, to calculate length-weight relationships,
- (c) sex composition in the catch (M, F, immature),
- (d) maturity stages by sex.

## 5. RECOMMENDATIONS

It is therefore recommended that the use of the templates already available for reporting on fishing activities of trawlers and of jiggers participating in the jumbo flying squid fishery in the Convention area be enforced from now on. And also, that given the importance it may have for the assessments, members be invited to provide the same type of templates for their past fishing activities, if available. In addition, it is recommended that an Observer Programme similar to the one already implemented for those vessels participating in the jack mackerel fishery be implemented for the jumbo flying squid.

**Table 1. Type, level of detail and coverage of fishery dependent data that would be required to facilitate the application of selected methods in the monitoring and assessment of the state of exploitation of jumbo flying squid (*Dosidicus gigas*) by the Scientific Committee of the SPRFMO**

ASSESSMENT METHODS	TYPE OF DATA / LEVEL OF DETAIL REQUIRED						TIME / SPACE COVERAGE REQUIRED	MAIN ASSUMPTIONS	MAIN LIMITATIONS	MAIN EXPECTED OUTPUTS	
	Catch	Fishing effort	Size structure	Abundance index	Biological data	Age estimates					Natural mortality
Biomass dynamic models	Yes / monthly (totals and by fleet)	Yes / monthly (by fleet)	No	Yes / monthly (CPUE)	No	No	No	5-10 years (whole stock area for catch & sample area for CPUE)	Catch is proportional to stock size and fishing effort. Strong density dependent effect dominates population dynamics, implying a strong depensatory stock-recruitment relationship	Requires good contrast in the time series with observations above and below $B_{MSY}$ . Can't incorporate biological information (as body growth, maturity or natural mortality)	Estimates of MSY, current biomass relative to $B_{MSY}$ , current F relative to $F_{MSY}$ and estimated catch that would correspond to $F_{MSY}$ or to a multiplier of $F_{MSY}$
Depletion estimates of stock size	Yes / monthly -and/or- weekly if possible	Yes / monthly -and/or- weekly if possible	Yes / monthly -and/or- weekly if possible	No	No	No	Yes	1-2 years (whole stock area)	Stock is randomly distributed. No recruitment. Closed stock that mainly declines due to fishing mortality. Abundance index is proportional to total abundance by mortality coefficient	Requires good separation among cohorts throughout the whole period under analysis	Estimates of initial biomass or stock size, or recruitment size if single cohort is assessed. Time series of initial biomass estimates or stock sizes if repeated over time
Virtual population analysis (VPA) and statistical catch at age models	Yes / monthly -and/or- weekly if possible	Yes / monthly -and/or- weekly if possible	Yes / monthly -and/or- weekly if possible	Yes / monthly -and/or- weekly if possible	Yes (length and/or age) / monthly -and/or- weekly if possible	Age-length relationship	Yes	5-10 years (whole stock area for catch & sample area for others)	The fished stock is formed by discrete cohorts	Requires good separation among cohorts	Estimates of recruitment, total biomass and fishing mortality coefficients
Age/length structured population models (similar to JIM)	Yes / monthly -and/or- weekly if possible	Yes / monthly -and/or- weekly if possible	Yes / monthly -and/or- weekly if possible	Yes (CPUE) / monthly -and/or- weekly if possible	Yes	Age-length relationship	Yes	5-10 years (whole stock area for catch & sample area for others)	Abundance index is proportional to population size		Time series estimates of stock abundance, biomass, recruitment abundance, fishing mortality coefficient, growth and recruitment parameters