Developing a database and relevant management indicators for monitoring commercial fisheries[1]

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Background

New Caledonia's three provinces — Northern Province, Southern Province and Loyalty Islands Province — have jurisdiction over their respective coastal fisheries. Each province collects its own catch data, issues fisheries regulations, and establish public policies aimed at supporting the fisheries sector.

Each year, as part of its responsibility to ensure statistical monitoring of economic data, New Caledonia produces a summary of the provincial data it has received. Given the need to standardise data and procedures, the three provinces expressed a desire to draft a common set of terms of reference before establishing standardised provincial databases.

New Caledonia's ZoNeCo programme[1] assisted with this work and the Secretariat of the Pacific Community (SPC) played an active role by developing the terms of reference. It was on this basis that the provinces proceeded with developing their respective databases.

Although the data collected by the three provinces are similar, different software is used to process the data, and the lack of a common taxonomic reference system makes compiling these data difficult and very imprecise.

The goals of developing databases for each province were to:

- facilitate the annual data compilation work carried out by the Merchant Marine and Maritime Fisheries Service (SMMPM);
- allow non-nominal data (i.e. the name of the fishermen is not linked with the data) to be exchanged between provinces; and
- facilitate data analysis and the production of summary reports.

Each database's structure and interface make it possible to:

- enter and print out fishing permits;
- enter details on the characteristics of fishing campaigns and related catches; and
- import permits and safety inspections from SMMPM software.

Applications are currently being developed for the Northern and Loyalty Islands provinces. The Southern Province has completed the development of its computer application, which is now operational.

Once developed, the databases will:

- serve as a tool to store data over long periods of time;
- allow managers to gain a clear picture of the coastal fisheries sector's production levels and special characteristics;
- make it possible to produce reports for decision-makers;
- allow fishing statistics to be shared with professionals; and
- allow extraction of summary data about the sector for SMMPM, using a taxonomical reference system that is common to all three provinces.

Objective

The large amount of data in the database (80,000 entries per year for the Southern Province) means that in-depth descriptive analyses of the coastal fisheries sector should be possible at several levels of detail (e.g. by species, group of species, season, geographic zone, gear, fisher, type of activity).

The goal of this pilot project is to 1) identify whether a database that is created from a common set of specifications can produce descriptive analyses of fisheries exploitation levels, and 2) analyse fisheries statistics so as to identify indicators of changes in reef and lagoon resources. The Southern Province's operational database was used for this study.

This approach involves technical support — in the form of additional information and statistical analyses — to provincial fisheries departments. It is important to note that this project does not, in any way, aim to replace the expertise and experience of fisheries managers who are vital for decision-making.

The ultimate goal is to provide decision-makers with a statistical picture of catch trends, which will allow them to enhance their perception of trends in the sector.

[1] This article is a summary by Manuel Ducrocq of Nicolas Guillemot's report (Guillemot N. 2011. Indicateurs d'évolution des ressources récifo-lagonaires pour la gestion et le suivi de la pêche professionnelle en Province Sud de Nouvelle-Calédonie. Rapport d'étude Zonéco (ADECAL), Nouméa, 50 p. + 91 p. annexes), which is available (in French) on the ZoNeCo website: http://www.zoneco.nc

[2] In 1990, New Caledonia and the Government of France set up a research programme called ZoNeCo (Zone Économique de Nouvelle-Calédonie) for the sustainable management of marine resources within New Caledonia's exclusive economic zone.

Source data

The database contains all information reported by fishers for each fishing trip.

A fishing trip is defined as the period between the departure time and return time from fishing. This period can vary from a few hours to a few days at sea.

"Spatial level" refers to the maximum spatial resolution at which fisheries activities can be described, and is determined by a grid given to each fisher on which the fisher indicates the zones that they fished in during the fishing trip.

Catch data on the quantity of products caught (in kilograms) are collected for each trip.

Many other types of economic data — such as fuel costs, crew pay, supplies — are also provided but were not used as part of this study.

In addition to being a management tool, the database is a very effective communications tool.

Variables calculated

Fishing trip and catch data were used to calculate relevant variables for exploitation such as catch per unit of effort (CPUE), which provides standardised information on fishing yield during a given trip.

CPUE can be expressed in kg/fishing day or in kg/fishing day/number of fishers onboard.

In the case of the Southern Province, the number of fishers onboard a vessel varies greatly. In order not to introduce any bias linked to this variable, and to ensure the detailed information needed for a robust analysis, the number of kg/fishing day/number of fishers onboard was used.

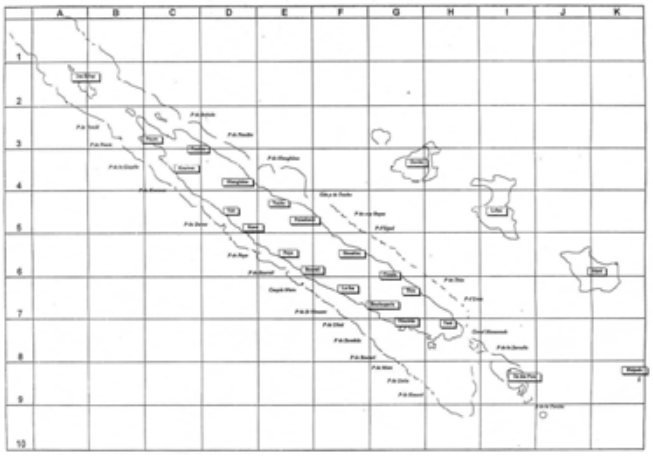
Types of analyses

Initial assumption

Currently, there are not enough biological data on all target species to determine the status of fishing stocks in a given zone within New Caledonia.

Harvests by commercial fisheries are only a very small part of the overall catch from the South Lagoon. In fact, declared and detailed catches from commercial fisheries account for only 25% of the total catch (which varies depending on the species). No other data (from scientific surveys or from the recreational fishery) were used.

Based on the assumption that CPUE makes it possible to standardise catches by effort, and to measure fishers' yields, the use of CPUE from commercial fisheries should provide useful information regarding changes in fishing activities and the status of resources.



A map of New Caledonia with a set of gridlines that indicate fishing zones.

In fact, for a given fishing characteristic, such as vessel type and size, technique and gear used, and know-how — the quantity of product caught within a certain amount of time and the relationship to historical data provide relevant information on resource abundance in a fishing zone.

Two main types of analyses can assist with the management of resources and fisheries activities: descriptive analyses and statistical analyses.

Descriptive analyses

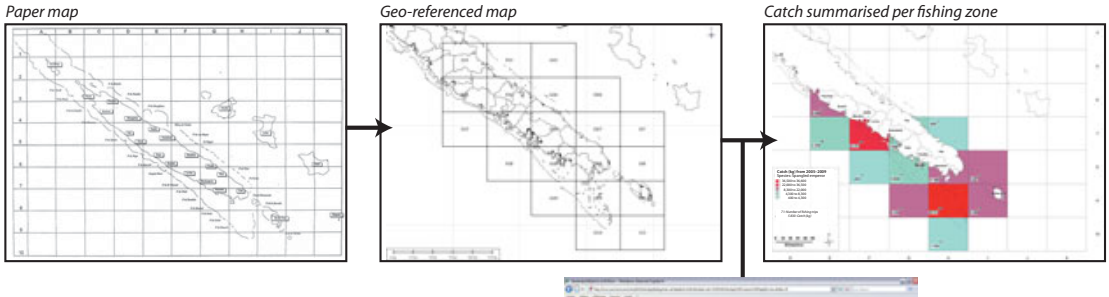
Descriptive analyses make it possible to examine trends in both time and space for each resource. The charts and graphs produced after the basic data have been extracted make it possible to describe fishing levels and changes to them.

Changes in catch and CPUE over time

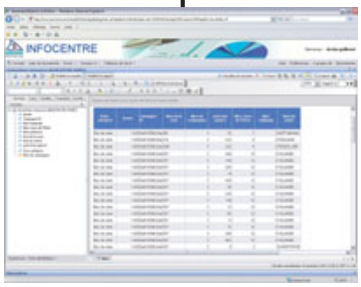
The main purpose of the graphs is to analyse trends in catches and CPUE for a given resource, and in particular, to detect downward trends. The graphs also make it possible to see intra- and interannual variability in catches and CPUE, which provide the background information needed to fully understand coastal fisheries in New Caledonia. In addition, having this type of summary output makes it possible to analyse (or highlight) the possible effects that external factors have on fishing levels, the consequences of changes in regulations, and even the impact of unusual weather events.

Catches and CPUE display different change characteristics and provide access to different but complementary information on fishing activities and their levels of change.

Catch data provide useful information on the fisheries sector and changes that occur over time. This information, however, is difficult to use for determining



Spatial distribution of catches is derived from the paper maps and data provided by fishermen.



Data extracted per fishing zone

the status of exploited resources because catches are subject to many factors (e.g. socioeconomic, cyclical, regulatory).

Reduced catches do not necessarily mean that the stock is diminishing, if at the same time the number of fishermen or the time of their fishing campaigns has diminished. But, if effort has been constant and catches are diminishing, then it can be assumed that stocks are likewise diminishing.

Spatial distribution of catch and CPUE

Reef and lagoon resource use levels cannot be described in any relevant way without examining spatial distribution. The reference grid that was used was digitised and georeferenced, and capture and CPUE data were extracted and then linked to geographic information from the fishing zone.

The maps show high variations in spatial distribution for both catches and CPUE, no matter what the resource is. The main interest in these graphics is to be able to get a more precise picture of the distribution of use and fishing pressure. In particular, when a general trend can be identified on a provincial scale, it can provide information on which fishing zones are most likely to be affected by this trend and which zones are likely to need specific management measures for a given resource.

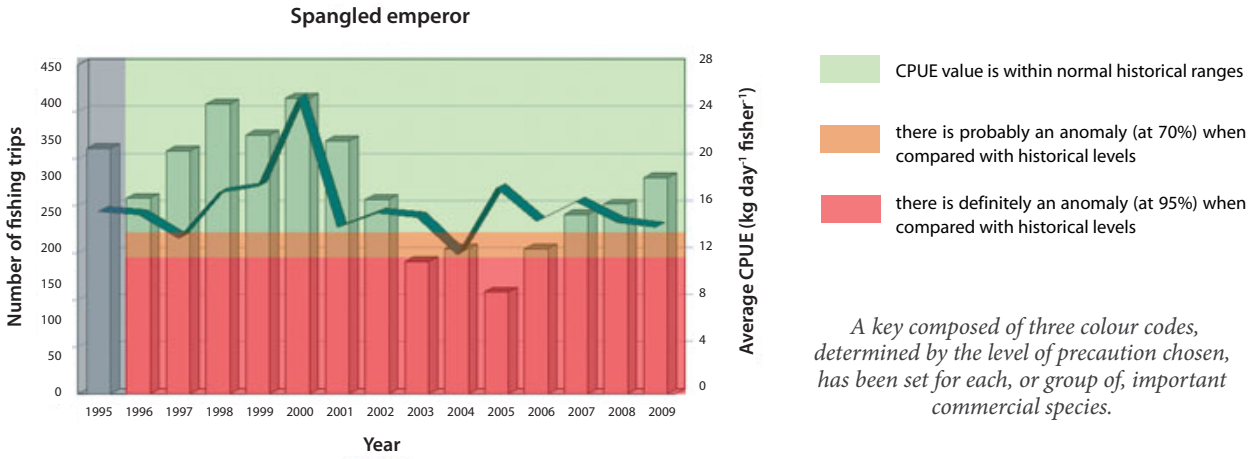
Statistical analyses

Statistical analyses are designed to calculate warning thresholds (regarding changes to these parameters) that alert fisheries managers to abnormal situations in exploitation levels.

Because the biological data needed to determine the health status of resources in New Caledonia is based on exploitation levels (and so, do not provide enough information), warning thresholds for resource use were set on the basis of historical variations in CPUE.

Thresholds calculated in this way for each exploited resource make it possible to detect variations in fishing levels as compared with historical levels.

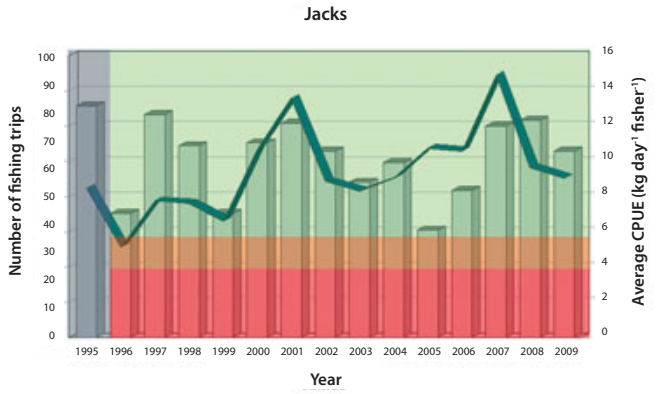
For a given resource, what range of variation observed makes it possible to state that one value is significantly different from the others?



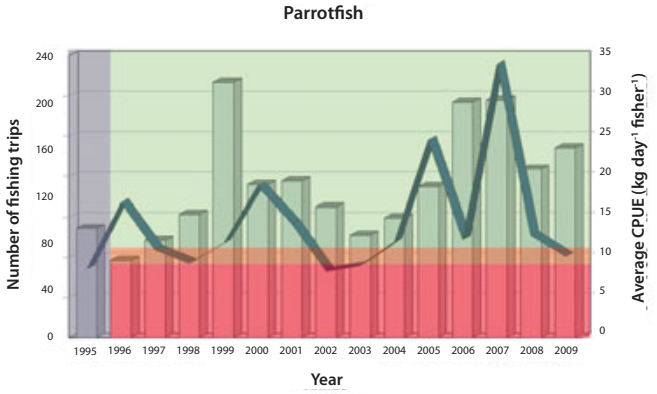
A key composed of three colour codes, determined by the level of precaution chosen, has been set for each, or group of, important commercial species.

The desired range, which allows thresholds to be set, differs for each resource and depends on the number of years of available data, the number of yearly fishing trips, the average number of years considered, interannual variation, and the desired level of precaution.

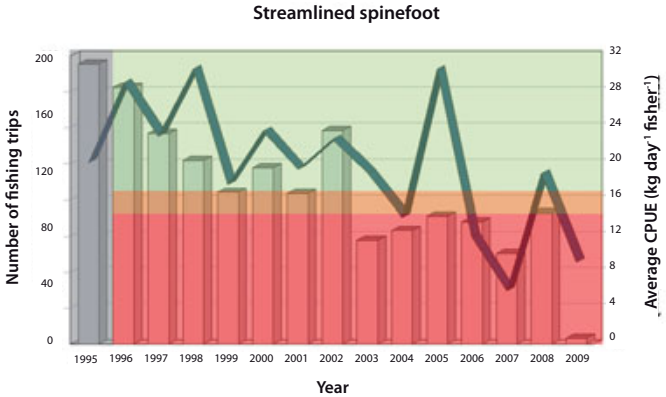
For each species or group of species involved, the sensitivity analysis carried out made it possible to produce a key composed of three colour codes determined by the level of precaution chosen. Some examples are given below.



An example of a resource whose 2009 CPUE value is within the normal historical range.



An example of a resource whose 2009 CPUE value shows a probable anomaly.



An example of a resource whose 2009 CPUE value shows a definite anomaly.

Thresholds provide warnings that the CPUE value is significantly lower than historical levels but they do not necessarily correspond to stock overexploitation levels because they do not provide any information on the biological health status of the resource.

Analyses of the main exploited resources in the Southern Province led to the identification of three levels of relevance for the proposed thresholds.

Relevant: The threshold values obtained are aligned with historical CPUE characteristics; they are within the tolerance of the historical interannual variability in the species concerned, and provide relevant warning levels. This relevance level covered 15 species caught in the Southern Province.

Uncertain: The threshold values obtained show a range that is clearly lower than the historically observed variation range. They are not very tolerant and these thresholds can be exceeded on a regular basis without this necessarily reflecting a downward trend or an abnormal situation. Such cases may appear with resources whose recruitment (and, therefore, abundance) varies greatly from one year to the next. The thresholds obtained can be used for information purposes. This relevance level covered two species caught in the Southern Province.

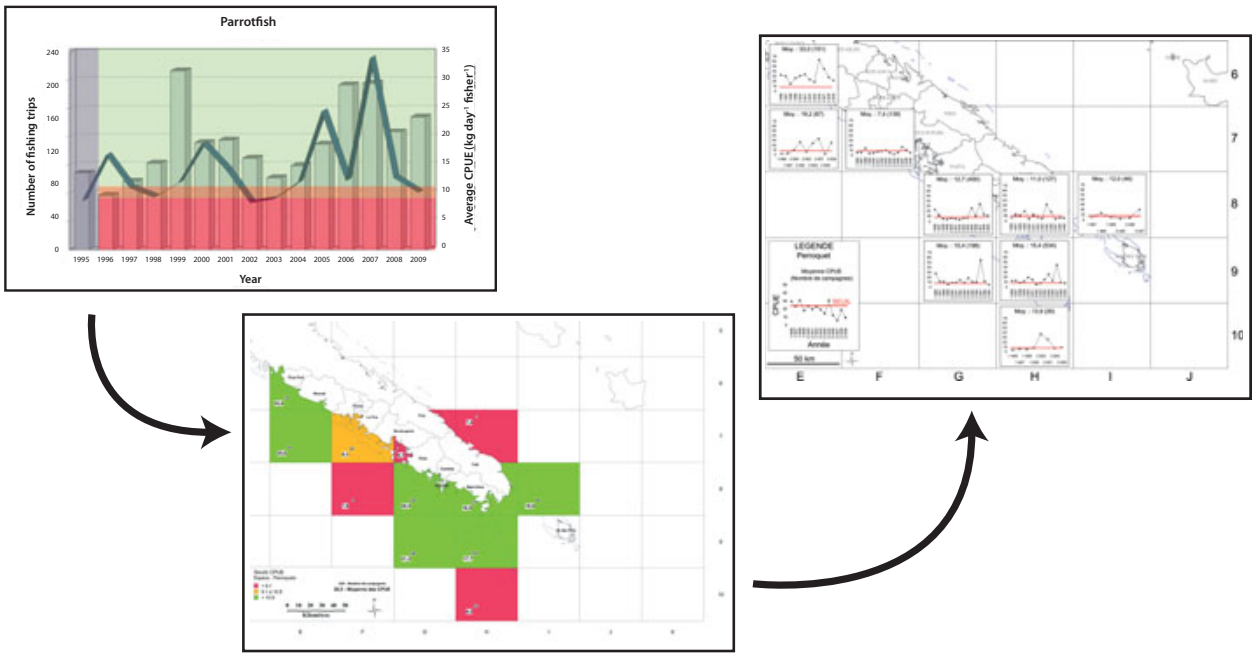
Unusable: The threshold values obtained show a range that is much greater than the historically observed range and is very far from average levels, which makes the thresholds too tolerant to be used in a relevant manner. This can be due to high intra-annual variability in data for such resources, which makes it impossible to calculate precise thresholds. This relevance level covers five species caught in the Southern Province.

For exploited resources as a whole, 75% of catch volumes can be monitored in a statistically relevant way which includes variation thresholds and set warning levels.

Sensitivity analyses were carried out for each category of resource in order to calculate the alert threshold using the statistical software G*Power, based on the characteristics of historical data from extractions done with Business Object and Excel. The thresholds set during this study do not need to be updated annually. They can take into account the historical characteristics of fishing levels over a 16-year period, and can be considered to be reference thresholds; they only need to be revised when there are changes in technology or regulations.

Spatial breakdown of thresholds and additional analyses

Once an alert threshold has been set, it is then possible to make a diagnostic of the presumed status of a resource on a province-wide scale. However, the spatial distribution of resources and fishing activities can vary greatly and so the spatial structure needs to be considered in order to formulate a relevant diagnostic.



Spatial breakdown of thresholds and additional analyses make it possible to identify fishing zones that are the sources of CPUE variation anomalies, and provide managers with the high quality information they need to make decisions.

Given that it was not possible to have specific thresholds for each fishing zone, CPUE spatial distribution was examined, particularly CPUE levels as compared with generic thresholds covering all of the Southern Province.

The maps make it possible to identify fishing zones that are the sources of CPUE variation anomalies, and provide managers with the high quality information they need to make decisions (a case of exceeding a threshold in a given zone does not lead to the same decisions as those made for broader trends).

Using generic thresholds to diagnose the CPUE level of a given fishing zone raises the issue of the zone's specific characteristics (particularly in terms of its productivity level). In fact, in the case of a zone where productivity is lower than the average for all zones, CPUE levels will probably be lower than the thresholds set for all zones. Therefore, historic CPUE levels for the fishing zone in question should be examined in order to determine if the recent values below the threshold are the result of a decrease in CPUE or from low natural productivity levels (historically low CPUE).

Mapping historical changes in CPUE makes it possible to 1) have a more accurate geographic definition of the diagnosis made using overall graphs, and 2) highlight those precise zones that are a problem in terms of abnormal CPUE variations.

Practical use of this tool

The diagnostic for all resources is done on an annual basis after all fishing logsheets have been entered.

When a threshold is exceeded, a range of factors needs to be examined.

External factors

Variations in CPUE can be influenced by outside factors that are independent of the resource's status, including:

- a significant change in the main operator(s);
- an unusual weather event;
- a change in regulations; and
- a change in technology.

If a major outside factor affects CPUE variations, it may be impossible to establish a reliable diagnostic because CPUE levels are not always comparable with historical levels, and thus, with the thresholds calculated from them.

If the change is significant and ongoing, the validity of the threshold may be compromised. Thresholds may have to be updated for the resources in question. Several years of data will then be needed to ensure that the new threshold is robust.

Data entry

The first step to take when a threshold has been exceeded is to check the data. By targeting data on the resource in question and the related operators, it is possible to eliminate any entry errors or mistakes in data information that could be the source of the false CPUE value for the year involved in the diagnostic.

When a threshold is exceeded and data problems and external factors have been eliminated, the possibility

of a problem with the status of the resource can then be raised.

Orange threshold, or pre-alert threshold

The purpose of this threshold is to ensure that the resource does not reach the red threshold. A suspected anomaly linked to an exceeded threshold should lead to a scientific study to determine the exact nature of the problem with the resource, and can lead, over the long term, to management measures designed to reverse the trend.

Conducting sampling protocols to analyse size spectrums and growth curves for the species in question should make it possible to compare the levels of the studied resource with biological references, and to deduce the study resource's health status.

Red threshold, a proven anomaly

This level should immediately lead to a specific study designed to clearly identify the origin of the anomaly and to assess the health status of the resource in question, as well as define relevant management measures. While waiting for the results of the study, conservative management measures designed to limit the abnormal trend are highly recommended**.** At the very least, categorising the resource as excluded or subject to special authorisation should allow a decrease in fishing pressure.

When a threshold has been exceeded, a detailed map-based analysis must be carried to clearly define the spatial scope of the anomaly by identifying those zones that caused the threshold to be exceeded and, within these zones, those that correspond to an actual downward trend (and not to a lower-than-average productivity level).

The mapping component appears to be vital for defining adequate compensatory measures and/or ordering specific studies.

Recommendations

For this pilot study, the data quality was sufficient for calculating thresholds for the species caught in the Southern Province. However, if data continued to improve in terms of quantity, quality and representation, this would significantly improve the precision of analyses, and better target their results, particularly in terms of calculating alert thresholds by geographic zone.

Improving collected data — Several points were noted where improvements could be made:

- *Standardising the basic observation unit (i.e. the fishing trip)* — Compiling data from several trips onto a single logsheet can led to bias in statistical analysis and does not allow the locations of catch data to be shown;

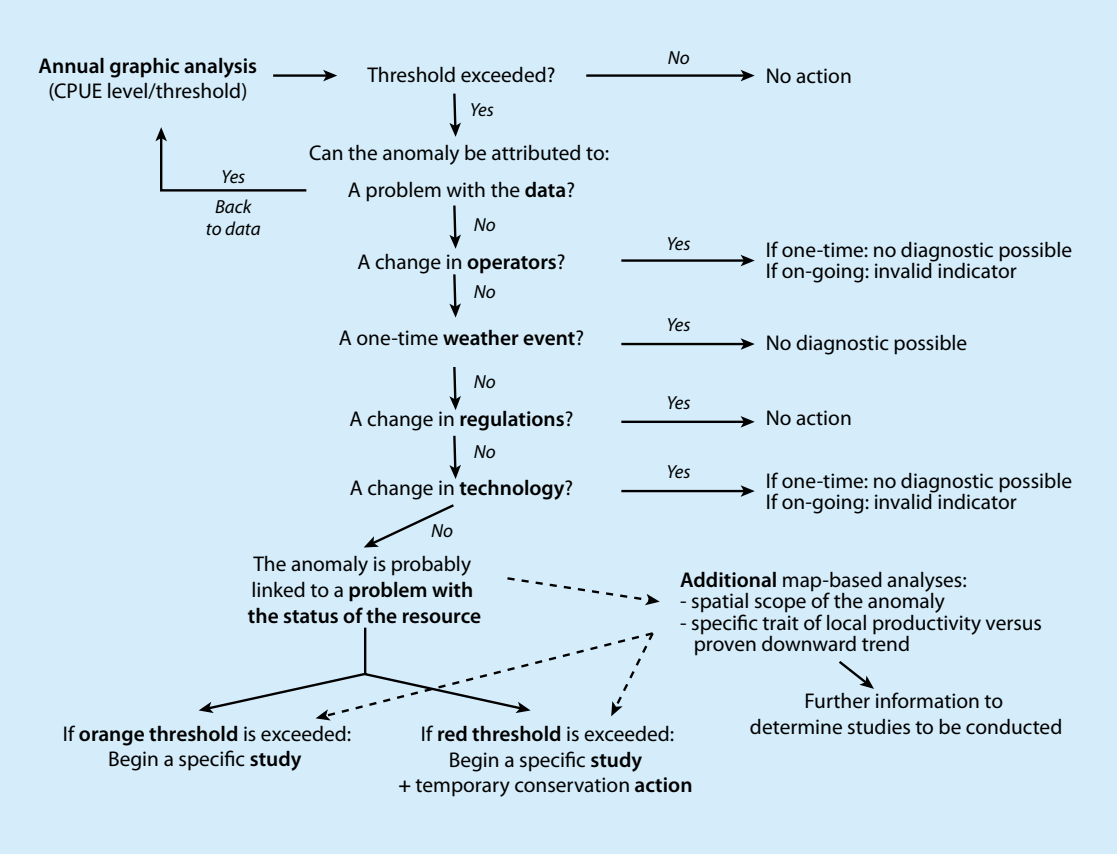


Chart of the priority actions to be taken when a threshold is exceeded.

- *Completing logsheets* — Some logsheets are only partially completed. However, if a variable needed to calculate CPUE is missing, the logsheet cannot be used, leading to a loss in data;
- *Fishing log coverage rates* — The higher the coverage rate, the more precise the analysis will be;
- *Refining data at the taxonomic species level* — The various species caught are grouped in categories. This clustering ensures that each category has enough data to carry out analysis but, more importantly, makes it possible to standardise fishers' reports, which vary greatly in terms of descriptions of species caught. Providing commercial fishers with an identification guide would allow analyses to be targeted to the species level, particularly in those categories that cover a large number of different species, whose interest for fisheries vary.

Providing each fisher with a yearly report on his/her activity, as the Southern Province currently does, allows fishers to benefit from concrete feedback on their reports and should contribute significantly to the above-mentioned improvements.

Improving the spatial distribution of data: Identifying fishing zones based on the grid currently used made it possible to examine the spatial distribution of exploitation levels, variations over time, and their situation in terms of alert thresholds. However, the size and layout of the squares used had some major disadvantages.

- *Zone size* is too large, so fishing activity can only by plotted very roughly. The size of the zones is not consistent with the small-scale diversity of habitats, resources and, consequently, practices;
- *Zone layout* does not take into account certain factors that provide natural structure to reef and lagoon populations, particularly the coast to offshore gradient.

Two options are possible for improving the spatial distribution of fisheries data.

- *Raw data collection:* Using a new grid layout is possible but there could be a problem with data continuity. In order to be able to analyse both older data and data from the new grid, the new fishing zones would need to be subcategories of the older ones. The grid's level of precision must be compatible with the level of detail fishers are likely to provide.
- *Further processing of data:* Linking maps that describe the main reef and/or lagoon habitats and geomorphic units to those that show species and/or fishing gear should make it possible to tie the data contained in the database to a limited number of habitats. Once CPUE data have been reassigned to corresponding habitats, they can then be mapped on existing geomorphologic or habitat charts. This approach has the advantage of not modifying the currently used grid. It provides relevant cartographic outputs and allows for greater precision. However, this option entails significant requirements in terms geographic information system analysis.

Towards new indicators

Fishing distance: The results of these analyses do not take into account the distance fishers must travel to ensure that they maintain their exploitation levels and the size of the fishing zones is too large to estimate any notable changes in this regard. This is likely to create a problem in interpreting the observed trends. In fact, observed catch and CPUE can remain stable over time, even when fishers must continually cover greater distances in order to maintain their exploitation levels. In such cases, an increase in resource scarcity would not be shown by the analyses. Therefore, it is important to know the distance the fisher travels during each fishing trip. Reducing the boundaries of the fishing zones could partly resolve this problem, and using fuel consumption data would make it possible to approximate the distance covered and to create a "quantity of fuel used" indicator. It would also be possible to directly consider CPUE corrected by the quantity of fuel used (in kg/litre of fuel/fisher).

Monitoring landings/biomonitoring: Recording biological factors (e.g. size, weight, gonad maturity) at the main landing sites would allow a comparison of these factors with referenced values for the concerned species; this would also make it possible to initiate a collection of biological data for each zone, as this is vital to evaluate stock health status.

Including socioeconomic data: The large amount of data entered into the database means it should be possible to expand descriptive analyses, and to identify socioeconomic indicators. Such an approach would allow us to focus on management aspects for both the sector and stakeholders in terms of economic performance. The added value of such an approach would double by implementing alert thresholds for abnormal changes in certain economic parameters for the sector, and by using factorial analyses that integrate various parameters from the sector. This would make it possible to create activity profiles, compare their performances and their impacts on resources, and provide managers and operators with precise information on relevant choices in terms of determining fleet typologies and project sizes, and better defining eligibility criteria for public aid.

Acknowledgements

Outcomes of this operation were made possible through the active involvement of the Southern Province, particularly the Office of Finance for developing the BIP-BIP software, and the Department of Rural Development/ Office of Fisheries for their involvement in the historical monitoring of this area.