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Monitoring protocol factsheets

Methodological guide for fisheries monitoring in Mediterranean Marine Protected Areas

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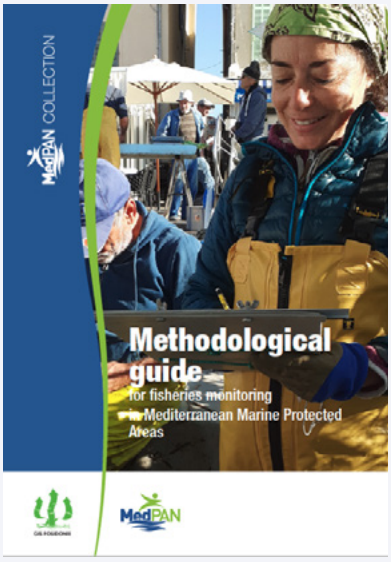

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SPECIAL CASE

SHEET 36 - Assessment of catches and associated professional fishing effort by survey: fixed fisheries case (tunny nets, cherfiyas, dalyan)

Estimate of the parent population of professional fishers

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Access to national, regional or local fisheries statistics or even European and international for MPAs bordering other states
- Presentation of the monitoring to fishers and their local and regional representatives
- Acceptance of professionals to participate in surveys

REMARKS

Pre-requisite for site use monitoring and landing surveys.

ACTIVITIES CONCERNED

Small coastal métiers: nets, longlines, traps including stationary traps, gathering, gangui, dredges and small offshore métiers: drift lines; but also but also fishers on foot and underwater, trollers.

Objectives and expected results

Objectives

- Estimate the parent population of professional fishers practising in the MPA, i.e. not only its size but also its structure by type of activity
- Know the main characteristics of the fleet concerned by the MPA (see fleet definition): the number and type of vessels and their age, the number of fishers and their age
- Have information on the activity profile of professional fishers working in the MPA territory: the métiers practised, the gear used, the target species, the fishing intensity (number of trips / year)

Expected results

- Qualitative and quantitative assessments (total number of fishers, vessels, vessel size and geographical distribution in the different ports)
- Typology of professional fishing (métiers practiced, seasonality)
- Extrapolation coefficient for site use surveys based on the structure of the survey population
- Establishment of a panel of professional fishers representative of the different profiles, if relevant
- Information on the feasibility of setting up a monitoring system for professional fishing

Protocol description

- To define the parent population of professional fishers, it is recommended to cross-reference
  - Documentary research: statistical data held by the administration (Ministry of Fisheries, institutes responsible for monitoring living or geographical resources and human sciences, chambers of commerce) and groups representing fishers, censuses and available studies and
  - Surveys: information that can be collected from the fishers themselves.
- Determining parent populations is a prerequisite for the fishing surveys proposed in the guide (see following sheets). This work is used for sampling strategies to be implemented as part of site use monitoring and surveys, landing and on-board survey protocols, socio-economic surveys, use evaluation and perception surveys.
- This Protocol may also be used to carry out a **survey prior to the establishment** of fisheries monitoring, regardless of the site, with the objective of deciding whether it is appropriate, depending on the context, and whether it is feasible to set up fisheries

SAMPLING: TIME UNITS

Frequency

Before the implementation of protocols for the study of site use, then updated every 5-10 years to take into account any changes in fishers's profiles

Duration

10 / 15 min

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and adjacent area (taking into account fishers based in non-MPA ports who work in part or in whole in the MPA) and conversely, ships present in MPA ports but working in the surrounding area (problem of geographical transfer)

FEEDBACK FROM EXPERIENCE

- Cap de Creus Marine Reserve (ES)
- Côte Bleue Marine Park (FR)
- Lastovo Islands Nature Park (HR)

monitoring. This preliminary survey of professional fishers may then include questions such as: *Would you be willing to participate in a monitoring of professional fishing? Would you be willing to participate in landing surveys? Would you be willing to take observers on board?*

- As far as statistics are concerned, information may be available on the Internet, but more often than not, steps must be taken with the administration and the institutes that hold the figures. This first, somewhat tedious task makes it possible to take stock of the knowledge and accuracy of the available data and can facilitate the organisation of surveys in ports and among fishers by indicating where to go and by allowing the number of people to be met to be predicted according to known estimates and thus to distribute its sampling effort by survey.
- The statistics and work available most often provide information for analysis at the scale of a coastline, at the regional scale, according to landing ports or a fishing territory including the MPA, but rarely at the scale of an MPA. The results of the surveys will thus make it possible to assess the importance of fishing in and around the MPA in relation to local, regional or national data.
- The surveys are carried out directly with the fishers of the territory concerned by the study (professional organisations such as prud'homies, cofradías, local committees, etc., must be notified, have statistics themselves and can provide assistance in contacting fishers).
- The difficulty is to identify the fishers working in the management area (MPA) and then to only take into account their activities related to this area. Even if the port of landing is located in the MPA, the fisher does not necessarily fish there.
- The questions that arise when developing the sampling plan for the parent population assessment survey are:
  - Delimitation of the study area: MPA and adjacent area (fishing territory) for a spatial comparison between reserve and non-reserve and for a temporal monitoring of the evolution of the distribution of fishing effort (increase in activity at the boundaries of protection areas, postponement of activity around newly managed areas, etc.), specific fishing area outside the MPA that may have indirect effects on the MPA
  - What statistical resources, studies on professional fishing including the territory of my MPA? Data availability? Date? Accuracy?
  - Who are the people to be investigated? How many? Where?
- The information to be collected is:
  - Fisher's identifier:
    - information on the fisher: gender, year of birth / age range
    - information about the boat: registration / name and size of the boat, home port, size of the boat, power of the motor, age of the boat, equipment of the boat (wheel, winch, net transfer, etc.)
  - Fishing habits:
    - fisher's experience: how long has he been fishing?
    - métiers, equipment and techniques used, by season
    - sites practiced (by type of métier, by season)
    - fishing period: all year round, week / weekend, daytime (morning, evening, anytime)
    - frequency of practice: number of fishing days (by métier if possible)
    - proportion of annual trips in the MPA
    - average duration of fishing trips
    - volume of catches (average per trip or total annual), main species fished in the year.
  - Additional information:
    - of your choice: perception of management, activity, other uses, etc. (see dedicated sheet)

Implementation advice

- Possible comprehensive approach for small MPAs and small fishing communities. If non-resident fishers or fishers from other regions / countries come to work in the MPA territory, care should be taken to meet them.
- Information on the gear used and targets is important, it allows to judge the versatility of the fishers and to help define their dependence on the MPA site or on these target species. When they exist, it is important to retrieve the data from the register concerning the EC fishing fleet (European countries) or neighbouring States if possible
- Catch information is not mandatory and is mainly used to characterise fishing intensity, define trends or relative data (catch proportions by type of fishing, region, season, category of fishers, etc.).
- The anonymity of the answers must be guaranteed to fishers and the results must be reported at an annual meeting or in a summary document

Difficulties, advantages / Disadvantages

Advantages

- This monitoring makes it possible to establish contact and facilitates exchange between the manager and the fisher directly or through scientists or investigators
- Construction of an appropriate and representative sampling plan
- In the absence of a fishers' register, this method is one of the few methods used to estimate the parent population of fishers in a defined area
- In case of misunderstanding of the question, the investigator may specify and / or re-explain if necessary

Disadvantages

- Requires significant preparatory drafting work to be relevant
- Time and contact with fishers necessary to carry out the surveys

Material

- Maintenance sheet

€ Estimated costs (€: low, €€: medium, €€€: high)

€	Human resources (help from internship students and / or volunteers can reduce costs)
€	Specific service for data collection (if outsourcing)
0	Investment / material
€€	Data analysis

Administrative procedures, legal provisions

- If surveys are recorded, ask the interviewee for permission and ensure compliance with the legislation in force relating to individual freedoms
- If the fisher's full contact details are requested, the data must remain confidential and comply with the legislation in force relating to individual freedoms

Type of results obtained / Metrics

- Basic metrics:
  - length, tonnage, power, age of vessels
  - type and percentage of métiers practiced / season / year
  - proportion of fishing time in and out of MPA / season / year
  - main catches / season / year
  - criteria for choosing a venue in the MPA

Graphical representations

- Tables, histogrammes of metrics

To go further

- Alban *et al.*, 2006. Methodological guidebook for socio-economic field surveys of MPA users. University of Western Brittany CEDEM / GdR AMURE (Brest, France). 45 p.
- Alban *et al.*, 2007. Marine Protected Areas Socio-Economic Data. A review of EMPAFISH field survey results. EMPAFISH program. University of Western Brittany CEDEM / GdR AMURE (Brest, France), 115 p.
- Leleu, 2012. Suivi et évaluation de la pêche professionnelle au sein d'une Aire Marine Protégée: protocoles d'enquêtes, et indicateurs de pression et d'impact. Application au Parc Marin de la Côte Bleue. Thèse de Doctorat, spécialité Océanographie, Aix Marseille Université, Marseille, France, 298 p.

Proportion of fishing gear used by commercial fishers in the MPA (Alban *et al.*, 2006; EMPAFISH Programme)

MPA	FAD	Trawl	Hook and line	Long line	Net	Pot	Spear fishing	Other	Purse seine	Answ. Rate
Cabo de Palos				50%	75%	50%				75%
Columbretes		70%		10%	15%					95%
La Graciosa			93%		21%	14%		7%		100%
Malta	52%	6%	6%	51%	7%	7%				87%
Medes				13%	81%			13%		100%
Monte da Guia			96%	14%	14%	22%			14%	100%
La Restinga			93%		7%	18%	64%	11%		96%
Sinis				22%	81%	36%				100%
Tuscany	--	--	--	--	--	--	--	--	--	0%
FULL SAMPLE	**27%**	**7%**	**28%**	**32%**	**21%**	**13%**	**5%**	**2%**	**2%**	**92%**

Questionnaire to define the activity of professional fishers working partially or totally in an MPA (Alban *et al.*, 2006; EMPAFISH Programme)

EMPAFISH Questionnaire on Professional Fishing
(Information about individuals will remain strictly confidential)

1. Date: _____
2. MPA Name: _____ 2bis: Fleet category: _____

INFORMATION ABOUT YOUR FISHING ACTIVITY

3. Name and registration number of your vessel: _____
4. Registration port: _____
5. Where do you live? Town: _____ County / Region: _____
6. Are you: ☐ Owner of your vessel ☐ Co-owner ☐ Not the owner
7. How many boats do you own? _____ boats
8. Year of birth: _____
9. Date you started fishing: _____
10. Size of the household: _____ people

11. What are the main technical features of your vessel(s)?

Boat number	Length (metres)	Tonnage (GT)	Engine power (kW)	Annual number of engine operating hours	Year of construction	Year of purchase	Usual crew size (including skipper)	If chartering. Max. no. of authorized passengers (not including crew)
1								
2								
3								

12. According to your estimation, what is the present second hand market-value of your boat and fishing gears? _____ €

13. Average distance between harbour and main fishing grounds (nautical miles)

When fishing inside the MPA	When fishing outside of the MPA
____NM	____ NM

14. What are the 5 major factors influencing your choice of fishing site? Please rank these features from the most important (1) to the least important (5).

	Please rank
Abundance of fish	
Weather conditions	
Presence of particular species	
Regulations	
Your experience	
Accessibility / proximity of the fishing area	
To go fishing where other fishermen already fish	
Proximity of a marine protected area	
Few fishers go fishing in this area	
Few other activities on this area (diving, surfing, sailing...)	
Other (please specify:)	

15. Details of your fishing activity

	Overall description	Description by gear		
Gear name		Gear 1	Gear 2	Gear 3
Main targeted species				
Name of species 1				
Name of species 2				
Name of species 3				
Annual number of trips				
Total number (trips/year)	Trips	trips	trips	trips
% in the MPA	%	%	%	%
Average trip duration (hours / trip)				
When fishing inside MPA	Hours	hours	hours	hours
When fishing outside MPA	Hours	hours	hours	hours

Estimate of the parent population of recreational fishers

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- MPAs and beyond to take into account non-resident fishers

REMARKS

None

ACTIVITIES CONCERNED

Shore fishing, on foot, underwater, on board

Objectives and expected results

Objectives

- Estimate the parent population of recreational fishers based on the structure of the survey population
- Assess the average overall fishing effort deployed on the MPA
- Possibly, have a first global assessment of catches (be careful not to make this type of assessment imprecise)
- Have general information on the profile of recreational fishers operating in the MPA territory and on their perceptions

Expected results

- Quantitative evaluations (estimate of the total number of fishers)
- Typology of recreational fishing (resident / non-resident anglers, activities practiced, seasonality)
- Extrapolation coefficient for site use surveys based on the structure of the survey population
- Establishment of a panel of recreational fishers

Protocol description

- To define the parent population of recreational fishers, it is recommended to cross-reference
  - Documentary research: statistical data held by the administration, chambers of commerce, tourist offices (see sheet 1 "Estimation of the parent population of professional fishers" and / or
  - Phone surveys, if nothing else is available or small MPA: surveys conducted locally face to face in strategic meeting locations
- Surveys are conducted by phone among the inhabitants of the territory concerned by the study (different scales are possible: MPA and adjacent territory, department or region of the MPA). These surveys can provide information for analysis at the MPA level if it is very extensive, more difficult at the level of a restricted fishing site within an MPA and more likely at the regional level. Depending on the influence of the MPA (remarkable site), the survey can be carried out at national level. Attention! In tourist areas, it is also necessary to take an interest in 'tourist fishers'
- The construction of the sampling plan for the telephone survey requires special attention and may vary according to the objectives of the study. The issues to be taken into account when developing it are mainly:

SAMPLING: TIME UNITS

Frequency

Before the implementation of protocols for the study of site use, then updated every 5-10 years to take into account any changes in the profile of fishers

Duration

Less than 10 minutes (~10 questions)

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPAs and areas of attractiveness for fishing (see section on Difficulties, advantages / Disadvantages)

FEEDBACK FROM EXPERIENCE

- Sinis and Maldiventre Island Protected Marine Area (IT)
- Columbretes Islands Marine Reserve (ES)
- Malta Fisheries Management Area (MT)

- On which scale to prospect?
- For fishing activity related to an MPA, the telephone survey most often focuses on a local or regional area (the national scale is not adequate to identify a population of fishers at a local level). The local fishing activity, the profiles of local fishers and their practices are not necessarily the same as those "averaged" at national level and their particularities can hardly be identified by a survey carried out at national level.
- What essential information do you want to obtain?
- Who are the people to be surveyed, according to what type of sampling?
- How to reach non-resident recreational fishers? The telephone survey is adapted to reach local fishers, but if the area has a high number of tourist visits, it should be supplemented by a study to target tourists

- Information to be collected:
  - Fisher's identifier:
    - basic information: gender, year of birth / age range, socio-professional categories, main place of residence / region / country, type of activity carried out (shore, walking, underwater, on-board fishing)
    - on-board and underwater fishing: vessel registration / name, type (rigid, inflatable, sailboat, kayak, other), vessel size, engine power, age of the vessel, port of attachment or launch
  - Fishing habits:
    - fisher's experience: how long has he been fishing?
    - types of fishing practised, gear and techniques used by type of fishing
    - sites practiced (by type of fishing)
    - fishing period: all year round, in summer, holidays, daytime (morning, afternoon, evening, indifferent)
    - frequency of practice: number of fishing days (by type of fishing if possible)
    - proportion of annual trips in the MPA
    - average duration of fishing trips
    - volume of catches (average per trip or total annual) and main species fished all year round
  - Additional information: questions on practices, perceptions and even socio-economic issues can be added (see corresponding sheets) for a survey that goes beyond the strict definition of the parent population. Example:
    - baits used
    - factors influencing the choice of fishing site: fish abundance, regulations, accessibility, landscape beauty, weather conditions, proximity to the MPA, low fishing presence / other uses in the area
    - main reason for fishing practice (pleasure of fishing, pleasure of eating fish caught oneself, need of this resource to feed oneself)

Implementation advice

- Telephone surveys are preferred over mail surveys because they provide faster responses and a better understanding of the questions (the interviewer can specify and / or re-explain, if necessary). This method is also more economical than on-site studies (but does not provide the same level of accuracy).
- This assessment is facilitated when recreational fishing is practised mainly by the inhabitants of the area. If the practice involve lots of tourists, it is more difficult to target surveys. The telephone survey method can only be applied when all categories of the population are equipped with a telephone with an accessible number (which is not always the case).
- Catch information cannot be considered accurate and is mainly used to characterise fishing intensity (Sparrevohn, 2013), define trends or relative data (catch proportions by type of fishing, region, season, category of fishers, etc.).) (ICES, 2010).
- The results of the surveys must be anonymous.
- When recreational fishers have to register or pay an access fee to be allowed to fish in the MPA, they constitute the parent population.

Difficulties, advantages / Disadvantages

A delicate point of the method is to define the scope of the study: how far from the site should the inhabitants be interviewed? The further away from the site, the lower the site use rate and the more expensive the survey becomes to conduct. There is a trade-off between exhaustiveness and cost.

Advantages

- The telephone makes it possible to reach a large audience in a limited time
- Allows to build an adapted and representative sampling plan
- In the absence of a fisher's register, this method is one of the few methods used to estimate the parent population of fishers in a defined area

Disadvantages

- Requires significant preparatory writing work to be relevant (provide for translation into several languages in tourist or border areas)
- Inaccuracy of answers when asked over a long period of time
- Bias due to lack of responses
- If the study site is subject to tourism and / or important site use in neighbouring countries, it will be more difficult to have a good representation of the parent population

Material

- Survey sheet

€ Estimated costs (€: low, €€: medium, €€€: high)

€€ Human resources (help from internship students and / or volunteers can reduce costs)
€€ Specific service for data collection (outsourcing + large number of people to contact)
0 Investment/ material
€€ Data analysis

Administrative procedures, legal provisions

- If interviews are recorded, ask the interviewee for permission and ensure compliance with the legislation in force relating to individual freedoms.
- If the fisher's full contact details are requested, the data must remain confidential and comply with tthe legislation in force relating to individual freedoms. In general, full contact details are not collected.
- If the person interviewed is a minor, the agreement and presence of at least one accompanying adult is required.

Type of results obtained / Metrics

- Basic metrics:
  - type of activities practiced
  - seasonality of practices
  - proportion of fishing time in and out of MPA / season / year by type of activity
  - main catches / season / year
  - criteria for choosing a venue in the MPA
  - proportion of resident fishers / tourists engaged in an activity in the MPA

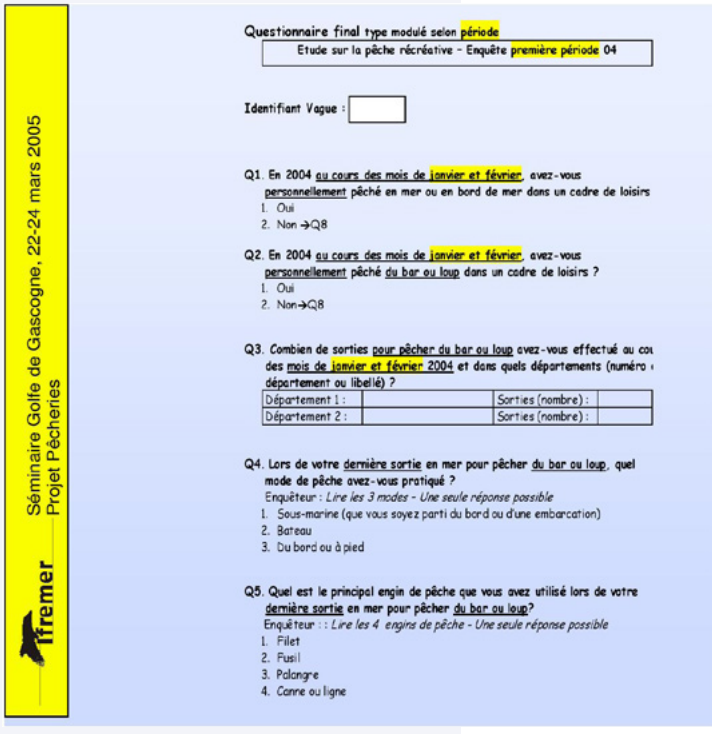
Graphical representations

- Tables, histogrammes, metric pie chart

To go further

- Alban *et al.*, 2006. Methodological guidebook for socio-economic field surveys of MPA users. University of Western Brittany CEDEM / GdR AMURE (Brest, France). 45 p.
- Alban *et al.*, 2007. Marine Protected Areas Socio-Economic Data. A review of EMPAFISH field survey results. EMPAFISH program. University of Western Brittany CEDEM / GdR AMURE (Brest, France). 115 p.
- Gamp *et al.*, 2016. Pêche récréative: un guide pour vous orienter dans vos méthodes de suivis – Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des aires marines protégées, Fr.: 199 pp.
- ICES, 2010. Report of the Planning Group on Recreational Fisheries (PGRFS), 7-11 June 2010, Bergen, Norway. ICES CM 2010/ACOM :34. 168 pp.
- Morizur *et al.*, 2005. Exploitation du bar commun par les pêches récréatives. Séminaire golfe de Gascogne, 22-24 mars 2005. Projet Pêcheries.
- Sparrevohn, 2013. Estimating recreational harvest using interview-based recall survey: implication of recalling in weight or numbers. Fisheries Management and Ecology 20: 52–57.

National telephone survey questionnaire on the sea bass *Dicentrarchus labrax* in France (Morizur *et al.*, 2005).



Séminaire Golfe de Gascogne, 22-24 mars 2005
Projet Pêcheries
Ifremer

Questionnaire final type modulé selon période

Etude sur la pêche récréative - Enquête première période 04

Identifiant Vague :

Q1. En 2004 au cours des mois de janvier et février, avez-vous personnellement pêché en mer ou en bord de mer dans un cadre de loisirs
1. Oui
2. Non →Q8

Q2. En 2004 au cours des mois de janvier et février, avez-vous personnellement pêché du bar ou loup dans un cadre de loisirs ?
1. Oui
2. Non→Q8

Q3. Combien de sorties pour pêcher du bar ou loup avez-vous effectué au cou des mois de janvier et février 2004 et dans quels départements (numéro ou département ou libellé) ?

Département 1 :		Sorties (nombre) :	
Département 2 :		Sorties (nombre) :	

Q4. Lors de votre dernière sortie en mer pour pêcher du bar ou loup, quel mode de pêche avez-vous pratiqué ?
Enquêteur : *Lire les 3 modes - Une seule réponse possible*
1. Sous-marine (que vous soyez parti du bord ou d'une embarcation)
2. Bateau
3. Du bord ou à pied

Q5. Quel est le principal engin de pêche que vous avez utilisé lors de votre dernière sortie en mer pour pêcher du bar ou loup?
Enquêteur : : *Lire les 4 engins de pêche - Une seule réponse possible*
1. Filet
2. Fusil
3. Palangre
4. Canne ou ligne

Séminaire Golfe de Gascogne, 22-24 mars 2005
Projet Pêcheries
Ifremer

Q6. Lors de votre dernière sortie pour pêcher du bar ou loup, dans quel département êtes vous allé ?
Enquêteur : Numéro de département ou libellé

	Numéro	Libellé
Département		

Q7. Lors de votre dernière sortie, combien de bars ou loups avez-vous pêché vous personnellement ?

Nombre de bars ou loups pêchés ?	
Pour quel poids global en kilos ?	

A tous

Q8. En 2003, avez-vous pêché du bar ou loup ?
1. Oui
2. Non Si pas de pêche de bar ou loup de l'année 2003 (Réponse NON en Q8) ni de pêche saisonnière en 2004 (Réponse NON en Q1) →STOP INTERVIEW

Q8a. Combien de sorties pour pêcher du bar ou loup avez-vous effectué au cours de l'année 2003 ?

Q8b. Quel poids total (en kilos) représentent vos prises de bar ou loup au cou l'année 2003 ?

Si Oui à la Q1 ou Oui à la Q8

Q9. Appartenez-vous à une association de pêche en mer ?
1. Oui
2. Non

Si Oui à la Q2 ou Oui à la Q8

Q10. Accepteriez-vous d'être recontacté d'ici la fin de l'année pour une enquête complémentaire sur la pêche de loisir en mer ?
1. Oui
2. Non

Code postal de l'interviewé(e) :

Site use counts / Fishing effort

Evaluation of the professional fishing site use and effort through visual census from a boat / at sea

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Notify professional fishers
- Identify sectors and periods of activity to set up the sampling strategy
- Obligation to mark fishing gear

REMARKS

Estimation through counting will not provide precise information on the métiers practiced, the fishing effort associated with a specific gear or practice, in particular the fishing time of the gear counted. Other protocols must be used for this

ACTIVITIES CONCERNED

Small coastal métiers: nets, longlines, lines, traps, including stationary traps, collection (no gear distinction possible, global consideration)

Objectives and expected results

Objectives

- Assess the use of the site by professional fishers: the main activities carried out, their density in the MPA and their interaction with the resource and natural habitats
- Know the spatial (maps) and temporal (days, seasons, years) distribution of these sampling activities on site
- Identify illegal fishing activities
- Be able to superimpose this distribution with a habitat mapping
- Better manage uses as part of a management plan, reduce conflicts
- Assess the means to be put in place to carry out awareness-raising actions
- Supplement, where appropriate, the data acquired by other protocols (surveys, counting from the coast, aerial survey, fishing logbook, etc.)

Expected results

- Quantitative assessments (number of gear, vessels, fishers) of fishing effort
- Qualitative assessments of professional fishing activities and practices (depending on the equipment of vessels, fishers)
- Location of activities to understand interactions with habitats to implement appropriate management measures
- Quantitative and qualitative assessments of illegal fishing activities (see corresponding sheet)

Protocol description

- Professional fishing activities are mainly practiced in the morning (early, before the sale e. g. red mullet fishing) or in the evening. Fishers are on the water at these 2 times of day and then move their gear. They set the stationary gear on periods ranging from a few hours (e.g. 1-3 hours for red mullet) to several days (e.g. lobster). The identification of gear (by surface signals, beacons on coral or sponge fishing sites) and fishing boats by visual census must be carried out within a fixed time frame (to be defined according to local practices, seasonal specificities).
- Boat-based counts are suitable for near shore and a little further offshore métiers, when the MPA is large and the coast is rugged or the seaside difficult to access. However, they are suitable when land access is complex, and the distance to be covered by vehicle or on foot is long.

SAMPLING: TIME UNITS

Period of maximum fishing activity or characteristic of the season

Monitoring periodicity

The protocol can be reproduced every season or at the same season with a regular annual time periodicity (every year, every 3 years)

Frequency

1 count / day at sunrise or 1 count in the morning and the evening (sunrise and sunset) to be done during the characteristic periods of the fishing season or of the targeted activity

Duration

Depending on the monitoring means and the fishing intensity

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around

Monitoring subunits

- Management areas, full protection, partial protection, regulation of certain fishing activities
- Sub-zones determined by zoning

FEEDBACK FROM EXPERIENCE

- Scandola Nature Reserve (FR)
- Port-Cros National Park (FR)
- Camargue Regional Nature Park (FR)

- The method is valid for small fishing fleets and métiers that are relatively close to shore (number of gear and number of GPS points of their surface signals, number of boats). It allows to cover large areas in a single trip and a short time (about 1 to 3 hours) depending on the size of the MPA. This method is not suitable for small offshore métiers.
- These counts are dependent on weather conditions, particularly sea condition, to ensure that fishing signals are clearly visible. The method is valid if professional fishers have the obligation and habit of properly reporting their gear. The reported registration allows the gear to be returned to a port or region.
- Information to be collected from a boat:
  - Information on the site and the day's conditions:
  - trip date, operator, weather conditions, sectors / zones and / or GPS point (in case of zoning, bring a plastic map), counting time on the sector in question, or counting start and end time
  - Counting gear and fishers:
    - › total number of gear (through surface signals: only one or one at each end), boats, by site / fishing area, description of the signal
    - › type of activity observed (stationary gear / towed gear / underwater fishing)
  - Additional information:
    - › GPS positions of fishing gear (= surface signals)
    - › observation of fishing in prohibited areas
    - › other users met (number of people and / or boats per site, by type of activity), but it is advisable to focus on fishing.

Implementation advice

- A counting sheet must be created before the protocol is implemented. This model should always be used during trips to avoid omissions and errors in data collection.
- The counting sheet can be in paper or digital format on a touch pad.
- A zoning must be established prior to the implementation of the protocol, limited by geomorphological markers that can be easily identified in the field (headlands, islets, structures, ports). Work at sea is made easier and this avoids losing a trip in the event of a GPS failure or omission (satellite reception problem).
- It is essential to sample also outside the managed areas in order to measure the effectiveness of management measures.
- A route can be established to avoid counting the same gear twice and to optimise travel between buoys (and fuel costs)
- The entire count must be carried out at the same time of day in a minimum of time (the objective is to obtain an instant picture of the fishing activity)
- The recommended period is rather the morning if the activity is not known (the majority of fishers work in the morning), but it must be adjusted according to local practices and métiers. It is best to count morning and evening, at sunrise and sunset, so as not to lose information about gear that have been set for less than 24 hours.
- At the beginning of the monitoring and if inexperienced people are mobilised (students on internships, volunteers), training must be provided to distinguish between different activities and fishing practices. These persons must be accompanied on their first trips at sea. Regardless of the experience of the counters, one or two calibration trips are required to familiarise yourself with the protocol and harmonise the procedure. Do not hesitate to renew regularly.

Difficulties, advantages / Disadvantages

- Depending on the degree of precision and the desired frequency, the human resources to be used can be significant
- The effort is significant during the acquisition period but the data obtained will be quantitatively and spatially accurate and the typology of activity is found seasonally

Advantages

- Accuracy of location through GPS positioning of surface signals of fishing gear deployed at sea and their possible attachment to a vessel (if registered), without disturbing fishers
- No technical qualification required
- Allows to cover large areas or the entire MPA

Disadvantages

- Requires good sea conditions and a good sense of observation
- Requires means at sea (a semi-rigid boat is ideal) and personnel
- Difficult to implement if there is a concentration of numerous and nearby gear (e. g. octopus pots)
- Does not give any indication of how the equipment is set

Material

- Boat (+ fuel), a pilot and a counter but cumulation possible
- GPS and / or zoning map
- Pair of binoculars
- Counting sheet held on a scoreboard / scoring tablet

€ Estimated costs (€: low, €€: medium, €€€: high)

€€ Human resources (help from internship students and / or volunteers can reduce costs)

€€ Specific service for data collection (boat and / or pilot)

€ Investment / material (including fuel €€) + touch pad if digital format

€€ Data analysis

Administrative procedures, legal provisions

- None

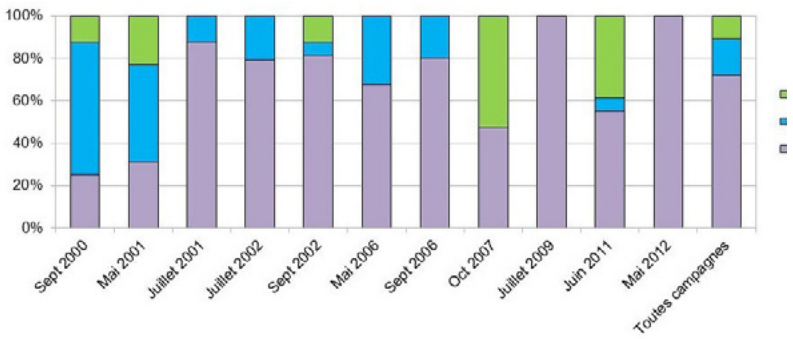
Type of results obtained / Metrics

- Fishing effort maps based on the distribution of gear or vessels
- Basic metrics:
  - number of gear / sector / day
  - number of professional fishing vessels / sector / day
  - port of origin of fishers operating in the area (through registration of gear and vessels, however, the port of registration may be different, or even very different, from the operating port)
  - number of illegal fishing acts
- Derived metrics:
  - average number of gear / sector / season or per year
  - average number of boats / sector / season or per year
  - average number of illegal fishing acts / sector / season or per year

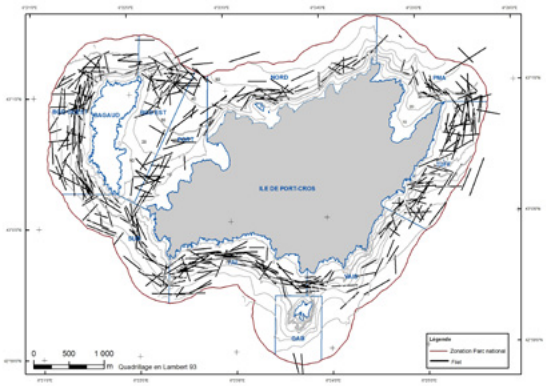
Graphical representations

- Tables, histogrammes of use by temporal (day, season, year) and spatial (sector / area) variables
- Maps of distribution of professional fishing gear
- Fishing intensity maps from gear density

Distribution (in %) of the gear recorded in the MPA according to the boat's port of origin (= registration on surface signals) (here example of the Scandola Marine Nature Reserve; © GIS Posidonie)



Map showing the distribution of gear recorded during the course of a year in the MPA (here the example of Port-Cros National Park; © GIS Posidonie)



To go further

- Le Diréach *et al.*, 2015. Suivi de l'effort de pêche professionnelle dans la réserve naturelle de Scandola (Corse). Données 2013. Contrat Parc naturel Régional de Corse & GIS Posidonie publ., Fr.: 54 p + appendices.
- Rouanet *et al.*, 2017. Suivi de l'effort de la pêche professionnelle dans les eaux de Port-Cros – Années 2014 à 2016. Partenariat Parc national de Port-Cros & GIS Posidonie, GIS Posidonie publ., Fr.: 54 p + appendices.

Example of a counting route at sea in the Gulf of Beauduc set up by Camargue Regional Nature Park (© Parc Naturel Régional de Camargue)

PROTOCOLE DE COMPTAGE EN MER DANS LE GOLFE DE BEAUDUC

Durée	Entre 3 et 4 heures
Heure de départ	9h-10h
Lieu de départ	Port Gardian
Sorties/mois	3 sorties/mois d'avril à septembre
Avant la sortie	- Vérifier les conditions météorologiques de la sortie avant de confirmer (**Il faut que les conditions soient propices à l'observation de fréquentation en mer ET qu'elles garantissent la sécurité des agents à bord**) - Remplir l'ordre de mission - Imprimer les fiches de comptage
Matériel nécessaire	- Les fiches de comptage à imprimer - Un stylo - Une tablette pour fixer et protéger les fiches - La carte de terrain - Une paire de jumelles - Un GPS/Sondeur (optionnel) - Une tablette électronique munie du zonage et d'une fonction GPS (à emprunter auprès de Philippe Isenmann) - Un compas

Itinéraire	1 – Mettre le cap vers le phare de Beauduc. 2 – A la limite avec la zone de la RNC, prendre le cap au Sud (180°) sur 1 km environ 3 – Mettre le cap sur la pointe de Beauduc (110°), jusqu'à 500 m environ de la côte 4 – Longer le littoral en maintenant environ 500m de distance à la côte 5 – Suivre l'alignement du phare de Beauduc et de l'habitation vers le large sur 2 km 6 – Longer le littoral à cette distance 7 – Dès que le compas indique un cap de 35°, maintenir ce cap jusqu'à se trouver dans l'alignement entre les balises Sud du cantonnement (à environ 1 km de celle du Sud-Est) 8 – Revenir à 500 m de la côte en mettant le cap vers l'herbier de Beauduc	9 – Longer le littoral à cette distance 10 – Arrivé au niveau de la balise Nord-Ouest du cantonnement, se rendre vers la balise centrale Ouest et faire demi-tour 11 – Longer le littoral à une distance de 500 m jusqu'au niveau du 3ème épi à l'Ouest du Petit-Rhône. 12 – Suivre l'alignement de cet vers le large sur 2 km 13 – Longer le littoral à cette distance jusqu'au niveau de la jetée de Port Gardian 14 – Rentrer au port

Evaluation of recreational fishing site use and effort by visual census from a boat / at sea

© GIS Posidonie

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Notify recreational fishers associations and federations
- Identify sectors and periods of activity to implement the sampling strategy

REMARKS

The count estimate will not provide accurate information on the practices, the fishing effort associated with a specific gear or practice, in particular the fishing time of the gear or the duration of the trip. Other protocols must be used for this.

ACTIVITIES CONCERNED

Shore, on-board, underwater, on foot fishing

Objectives and expected results

Objectives

- Assess the use of the site by recreational fishers: the main activities carried out, their density in the MPA and their interaction with the resource and natural habitats
- Know the spatial (maps) and temporal (days, seasons, years) distribution of these sampling activities on site
- Identify illegal fishing activities
- Be able to superimpose this distribution with a habitat mapping
- Better manage uses as part of a management plan, reduce conflicts
- Evaluate the means to be put in place to carry out awareness-raising actions on the site
- Supplement, where appropriate, the data acquired through other protocols (surveys, counting from the coast, aerial survey, fishing logbook, etc.).

Expected results

- Quantitative assessments (number of vessels, fishers, gear) and fishing effort. Evaluation of the number of fishing actions, but not of the number of different fishers practicing in the MPA.
- Qualitative assessments of recreational fishing activities and practices (depending on vessel and fisher equipment)
- Location of activities to understand interactions with habitats in order to implement appropriate management measures
- Quantitative and qualitative assessments of illegal fishing activities (see corresponding sheet).

Protocol description

- Three types of counting can be considered, and conducted in parallel:
  - Monitoring of use at a specified time 'T', randomly repeated over a defined period of time to take into account the spatial and temporal distribution and variability of activity over the course of a year or season
  - Monitoring of use over a full day from a fixed point to study the fluctuation in use (peak use). This type of monitoring can be carried out at the beginning of the study to identify the appropriate times when use is optimal for a monitoring at a fixed time.
  - Monitoring of use at a fixed time (to be defined according to local practices), assumed to be the peak(s) of use for the day according to the fishing activities practiced

SAMPLING: TIME UNITS

Cerbère-Banyuls Marine Nature Reserve (FR)

3 counts per week throughout the year distributed between weeks and weekends, and 1 count per day in July and August and consideration of fishing actions at sunrise and sunset

Port-Cros Natinal Park (îsland of Porquerolles) (FR)

5 half-days / week in July and August

Time slot: morning (7am to 12pm), afternoon (2pm to 7pm

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around

Monitoring subunits

- Areas by management category: total, partial protection, regulation of certain fishing activities as authorised / prohibited hunting.
- Sub-areas determined by zoning

FEEDBACK FROM EXPERIENCE

- Cerbère-Banyuls Marine Nature Reserve (FR)
- Port-Cros National Park (Porquerolles Island) (FR)
- Camargue Regional Natural Park (FR)

- Boat-based counts are suitable for fishers on foot and shore fishing when the MPA is large (but not too large!) and the coast is rugged or difficult to access. For on-board fishing and hunting, they are well adapted because they make it possible to precisely count these activities over the entire coastal strip (number and type of gear, GPS points of the boats and type of mooring used if relevant, to assess the pressure on habitats).
- These counts are dependent on weather conditions. They make it possible to cover large sectors or the entire MPA.
- Information to be collected from a boat:
  - Information on the site and the day's conditions:
    - trip date, operator, weather conditions, sectors / zones and / or GPS point (in case of zoning, bring a plastic map), counting time on the sector in question or start and end time of counting
  - Fishers count:
    - total number of fishers per fishing site (sector / area), number of surface buoys (underwater hunter), total number of vessels (on-board fishing), number of fishers per vessel (on-board fishing)
    - type, size of boat, anchored or drifting boat (on-board fishing, underwater hunting)
    - number of fishers by type of fishing
  - Gear count:
    - number of gear per fisher (if visible)
  - Additional information:
    - GPS positions when the monitoring allows you to be close to fishers and if time is available
    - observation of fishing in prohibited areas
    - other users met (number of people and / or boats per site, by type of activity, type of mooring used), but it is advisable to focus on fishing

Implementation advice

- Generally, fishers over 15 years of age are taken into account.
- A count sheet must be created before the protocol is implemented. This model should always be used during trips (to avoid omissions and errors when jotting down information).
- The counting sheet can be in paper or in digital format on a touch pad
- A zoning must be established prior to the implementation of the protocol, limited by geomorphological markers that can be easily identified in the field (headlands, islets, structures, ports). This makes it easier to work at sea and avoids losing a trip in the event of a GPS failure or satellite reception problem.
- It is essential to sample also outside the managed areas in order to measure the effectiveness of management measures.
- A route can be established to avoid counting the same gear twice and to optimise travel between buoys (and fuel costs).
- The entire count must be carried out at the same time of day in a minimum of time (the objective is to obtain a snapshot of the fishing activity). For large MPAs, several people can be mobilised at the same time to take a photograph of the site at a given time. Beware of duplicates in the counts: a precise breakdown is necessary and a clear distribution of the sectors of each team.
- At the beginning of the monitoring and if inexperienced people are mobilised (students on internships, volunteers), training to distinguish between the different activities, users must be provided. These people must be accompanied on their first trips at sea.
- Regardless of the experience of counters, 1 or 2 calibration trips are required to familiarise yourself with the protocol and harmonise the procedure. Do not hesitate to repeat the calibration regularly.

Difficulties, advantages / Disadvantages

- Depending on the degree of precision and the desired frequency, the human resources needed can be significant
- The effort is significant during the acquisition period but the data obtained will be quantitatively and spatially accurate and the typology of activity is found on a seasonal basis
- Some recreational fishing activity take place at night

Advantages

- Accuracy of location through GPS positioning of surface signals of fishing gear deployed at sea, and their attachment to a vessel, without disturbing fishers
- Allows to cover large areas or the entire MPA

Disadvantages

- Requires good sea conditions and a good sense of observation
- Requires means at sea (a semi-rigid boat is ideal) and personnel

Material

- Boat (+ fuel), pilot and counter
- GPS and / or zoning map
- Pair of binoculars
- Counting sheet held on a scoreboard / scoring tablet

€ Estimated costs (€: low, €€: medium, €€€: high)

€€ Human resources (help from internship students and / or volunteers can reduce costs)

€€ Specific service for data collection (boat and pilot)

€ Investment / material (including fuel **€€**) + touch pad if digital format

€€ Data analysis

Administrative procedures, legal provisions

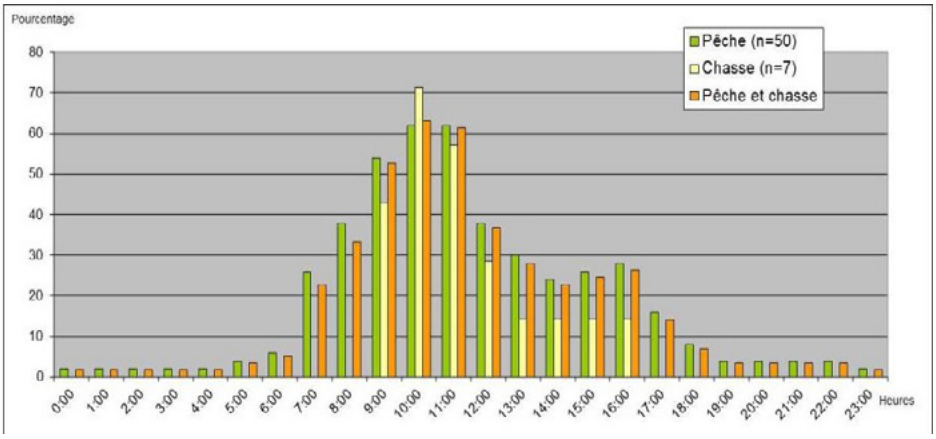
- None

Type of results obtained / Metrics

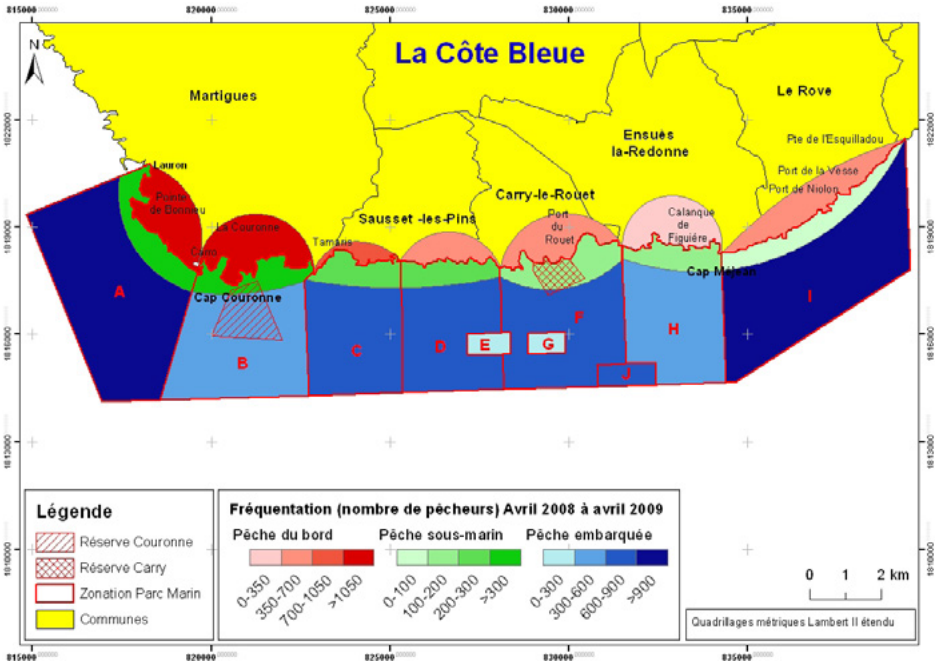
- Basic metrics by activity:
  - number of boats
  - number of fishers
  - number of fishers per vessel
  - number of gear per fisher
  - number of illegal fishing acts
- Derived metrics:
  - average number of boats / sector / season or per year
  - average number of fishers / sector / season or per year
  - average number of fishers per vessel / sector / season or per year
  - average number of gear per fisher / sector / season or per year
  - average number of illegal fishing acts / sector / season or per year

Graphical representations

- Tables, histogrammes of use according to temporal (day, season, year) and spatial (sector/area) variables
- Maps showing the distribution of fishing activities, fishing gear deployed and their intensity in terms of use



Hourly distribution (in %) of recreational fishing categories identified in the MPA (here example of Porquerolles Island, Port-Cros National Park; © GIS Posidonie).



Map of recreational fishing use (number of fishers) by different activies in the different sectors of the MPA (here example of the Côte Bleue Marine Park ; © Parc Marin de la Côte Bleue and GIS Posidonie).

To go further

- Gamp *et al.*, 2016. Pêche récréative: un guide pour vous orienter dans vos méthodes de suivis – Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des aires marines protégées, Fr.: 199 pp.
- Verbeke *et al.*, 2013. La gestion de la pêche de loisir dans les aires marines protégées. Recueil d'expériences des gestionnaires. ATEN, coll « Cahiers techniques » n°87: 112 pp.

Survey of recreational fishing and other activities at sea counting sheet in the Gulf of Beauduc (Camargue Regional Nature Park)

Parc naturel régional de Camargue

NATURA 2000

Date :	/ /

N° Sortie	
Page	1

Fiche de comptage en mer — **GOLFE DE BEAUDUC/OUEST CAMARGUE/CARTEAU**

Observateurs :	.....
.....	.....
.....	.....
.....	.....
.....	.....

Heure de début :	h
Heure de fin :	h

Matin :	Après-midi :
Météo :	Météo : .....
Nébulosité :	Nébulosité : .....
Vent :	Vent :
Direction (origine) :	Direction (origine) : .....
Force (Beaufort) :	Force (Beaufort) : .....
Etat de la mer :	Etat de la mer : .....

Limite d'entrée dans la zone	**Nom de la zone**	Limite de sortie de la zone
	Code PAMPA de la zone	

ACTIVITES DE PECHE DE LOISIR COTIERE			
Pêcheurs à la ligne du bord		Lignes	
Autres :			
Pêche à pied amateur		Pêche sous-marine	

LOISIRS NAUTIQUES			
Jet-skis, VNMs		Kitesurfs	
Voiliers légers et planches à voile			
Avirons, canoë-kayaks et pirogues			
Barques, pédalos		Surf, paddles	

EMBARCATIONS DE PLAISANCE		
Voiliers		
Navires motorisés		
DONT :		
Navires en action de pêche	Navires	
	Lignes	
Navires ancrés		
Navires beachés		

LOISIRS SOUS-MARINS		
Plongeurs PMT		
Plongeurs bouteille	Navires	
	Plongeurs	

PECHE A PIED PRO	
Telliniers	
Pêcheurs à pied sous-marins	
PECHE PETITS METIERS	
Navires	
Signaux de pêche	

FREQUENTATION AERIENNE	
Avions de transport civils	
Avions et hélicoptères militaires	
Avions de survol panoramique civils	

Commentaires :	.....
.....	
.....	
.....	
.....	

Site use counts / Fishing effort

Evaluation of professional fishing site use and effort by visual census from the shore / land

© GIS Posidonie

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Notify professional fishers
- Identify sectors and periods of activity to implement the sampling strategy
- Obligation to report fishing gear

REMARKS

The count estimate will not provide precise information on the métiers practised, the fishing effort associated with a specific gear or practice, in particular the fishing time of the counted gear. Other protocols must be used for this.

Depending on the number of fishers, recreational and professional fishing can be counted at the same time

ACTIVITIES CONCERNED

Small coastal métiers: nets, longlines, traps, including stationary traps, collection (no distinction between gear possible, global consideration)

Objectives and expected results

Objectives

- Assess the use of the site by professional fishers: the main activities carried out, their density in the MPA and their interaction with the resource and natural habitats
- Know the spatial (maps) and temporal distribution of these sampling activities on site (days, seasons, years)
- Identify illegal fishing activities
- Be able to superimpose this distribution with a habitat mapping (more difficult than for boat or aerial counts because position is less accurate)
- Better manage uses as part of a management plan, reduce conflicts
- Assess the means to be put in place to carry out awareness-raising actions
- Complete, if necessary, the data acquired by other protocols (surveys, counting from a boat, aerial surveys, fishing logbook, etc.).

Expected results

- Quantitative assessments (number of gear, vessels, fishers) of fishing effort at time T (extrapolations will not give a total number of fishers)
- Qualitative assessments of professional fishing activities and practices (depending on the equipment of vessels, fishers)
- Location of activities to understand interactions with habitats in order to implement appropriate management measures
- Quantitative and qualitative assessments of illegal fishing activities (see corresponding sheet

Protocol description

- Professional fishing activities are mainly carried out in the morning (early, before the sale direct, market, auction) or in the evening (example of the red mullet premium). Fishers are on the water at these two times of the day and then move their gear. They set the passive gear on periods ranging from a few hours (e.g. 1-3 hours for mullet) to several days (e.g. lobster). The identification of **fishers** (working on board), **gear** (by surface signals, beacons on coral or sponge fishing sites) and fishing **boats** by **visual census must be carried out within a fixed time frame** (to be defined according to local practices, seasonal specificities).

SAMPLING: TIME UNITS

Monitoring periodicity

The protocol can be carried out throughout the year. If a period is to be preferred, choose the periods of maximum fishing activity

Frequency

1 count / week or every 2 weeks, in the middle of the day or half day depending on activities

Duration

Variable according to the distance to be covered, the condition of the trails and the accessibility conditions

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around

Monitoring subunits

- Areas by management category: total, partial protection, regulation of certain fishing activities
- Sub-areas determined by zoning

FEEDBACK FROM EXPERIENCE

- Camargue Regional Natural Park (FR)

- The counts from the coast are adapted to the métiers practiced near the shore (post nets set at the coast, beach seines, shellfish and sea urchin harvesting, etc.), on sites offering good visibility. The method is applicable to métiers in the coastal strip if the coastal fringe is limited (e. g. large beaches or accreted shoreline), with good visibility (good weather conditions). However, the information collected is limited to: number of gear (surface signals), boats, fishers. Whenever possible, counts can be carried out from a semaphore or from a high point of view, which makes it possible to obtain the precise location of vessels through radar control and to locate fishing gear (= surface signals) using a pair of binoculars. Beware of underestimations due to insufficient visibility (do not hesitate to test the protocol by control counts carried out from a boat).
- Information to be collected from the coast:
  - Information on the site and the day's conditions:
    - trip date, operator, specific sectors / areas (in case of zoning, use of a recommended map), counting time on the area in question, weather conditions
  - Counting of fishers:
    - total number of gear (= surface signals), boats, fishers by site / area of fishing
    - type of activity (passive gear / towed gear / underwater fishing / gathering)
  - Additional information:
    - other users met (number of people and / or boats per site, by type of activity)
    - GPS positions of fishing gear (= surface signals)
    - observation of fishing in prohibited areas

Implementation advice

- A count sheet must be created before the protocol is implemented. This model should always be used during trips (to avoid omissions and errors when jotting down information).
- The counting sheet can be in paper or digital format on a touch pad.
- It is advisable to describe the protocol in detail for teams likely to implement it
- A zoning must be established prior to the implementation of the protocol, limited by geomorphological markers that can be easily identified in the field (headlands, islets, structures, ports). This facilitates field work and avoids waisting a trip in the event of GPS failure or omission or satellite reception problems.
- It is essential to sample also outside the managed areas in order to measure the effectiveness of management measures.
- When land access is difficult, or when the distance to be covered by vehicle or on foot is long, boat access should be preferred.
- The entire count must be carried out at the same time of day in a minimum of time (the objective is to obtain a snapshot of the fishing activity).
- The recommended period is rather the morning if the activity is not known (the majority of fishers work in the morning), but this must be adjusted according to local practices and targeted métiers.
- In the case of land counting, the entry and exit times must be recorded for each zone crossed. Each observed activity should only be counted when the agent carrying out the counting reaches its level. This avoids double counting, as well as assigning a use to an inaccurate area. A use located from a distance which activity is not clearly determined may sometimes require the agent to leave his itinerary in order to get closer to acquire more precision. The ability to observe is specific to each agent. In order not to waste time, defined routes can incorporate viewpoints from which the extremities of each area can be observed with sufficient clarity. However, it is important to reduce the counting time in each zone, in order to have accurate data over time for each monitored zone.
- If inexperienced people are mobilised (students on internships, volunteers), training must be provided to distinguish between different activities and fishing practices. These people should be accompanied on their first trips along the coast. Regardless of the experience of the counters, 1 or 2 calibration trips are required to get familiar with the protocol and harmonise the procedure. Do not hesitate to repeat regularly.

Difficulties, advantages / Disadvantages

- Needed human resources can be significant, depending on the degree of precision and the desired frequency.
- The effort is significant during the acquisition period but the data obtained will be quantitatively and spatially accurate and the type of activity is seasonal.
- In the case of foot fishing, professional fishing can be sampled at the same time as recreational fishing (Privat *et al.*, 2013, 2018).

Advantages

- Good accuracy on the location of fishing activities on the coast
- No need for means at sea and therefore less expensive
- From a high point: hill, semaphore, lighthouse, etc. the visibility of fishing gear (= surface signals) is better
- The method makes it possible to avoid weather-related problems except for conditions that reduce visibility (mist, fog)

Disadvantages

- Requires good visibility and a good sense of observation
- Lack of precision on the localisation of the fishing gear deployed

Material

- GPS and / or zoning map
- Pair of binoculars
- Counting sheet held on a scoreboard / scoring tablet

€ Estimated costs (€: low, €€: medium, €€€: high)

€€€	Human resources (help from internship students and / or volunteers can reduce costs)
0	Specific service for data collection
€	Investment / material + touch pad if digital format
€€	Data analysis

Administrative procedures, legal provisions

- Administrative authorisations required to access restricted access areas (routes through private property, military areas, etc.)
- Authorisation to access the competent authorities at semaphore, lighthouse, viewpoint located on a restricted access site

Type of results obtained / Metrics

- Fishing effort maps based on the distribution of gear or vessels
- Basic metrics:
  - number of gear
  - number of professional fishing vessels
  - port of origin of fishers operating in the area (through registration of gear and vessels)
  - number of illegal fishing acts

- Derived metrics:
  - average number of gear / sector / season or per year
  - average number of boats / sector / season or per year
  - average number of illegal fishing acts / sector / season or per year

Graphical representations

- Tables, histogrammes of use by temporal (day, season, year) and spatial (sector / area) variables
- Maps of the distribution of boats or professional fishing gear and their density

To go further

- Chalard, 2017. Mise en place d'un suivi de la fréquentation en mer et sur le littoral en Camargue. Rapport de stage Master2, Aix-Marseille Université, Parc naturel Régional de Camargue, GIS Posidonie, MIO. 35 p. + appendices.
- Privat *et al.*, 2013. Etude et diagnostic de l'activité de pêche à pied récréative: cahier méthodologique et recueil d'expériences. CPIE Marennes Oléron et VivArmor Nature, 138 p. + appendices.
- Privat *et al.*, 2018. Etude et caractérisation de la pêche à pieds récréative. Cahier méthodologique. 297p.

Protocol for counting fishing and recreational activities from land (Parc naturel Régional de Camargue)

La plage de Piémanson

Durée	Entre 1h30 et 2h30 (en cas de forte fréquentation)
Heure de début	11h30
Lieu de départ	**Extrémité Sud-ouest de l'aire de stationnement**
Sorties/mois	4 sorties par mois d'avril à septembre, 2 sorties par mois d'Octobre à Mars

JAN	FEV	MAR	AVR	MAI	JUN	JUI	AOU	SEP	OCT	NOV	DEC

	1 fois/semaine
	1 fois/2 semaines

Distance à parcourir	8 km

Itinéraire	Consignes de comptage
1 – Se garer à l'entrée de l'aire de stationnement, sur la partie en dur à gauche de la route, puis se rendre vers l'Ouest en gagnant le rivage.	Compter uniquement les usages à forte mobilité, susceptibles de quitter la zone rapidement, rencontrés (Fréquentation aérienne, navires de plaisance, de pêche petits métiers, loisirs nautiques, randonneurs équestres, randonneurs pédestres sur le retour).
2 – Longer le rivage toujours en direction de la limite Ouest de la plage.	
3 – S'arrêter au niveau de la fin de la dune située au milieu de la plage et délimitée par des ganivelles.	Observer à l'aide des jumelles et comptabiliser les usages sur la plage et en mer, jusqu'à la limite Ouest de la zone, matérialisée par le commencement de la digue et son prolongement en mer, perpendiculaire au rivage.
4 – Faire demi-tour et longer le rivage jusqu'au poste de secours. S'arrêter avant de passer devant le poste de secours.	Compter les différents usages rencontrés le long du trajet, sur la plage et en mer. S'arrêter de compter avant de passer devant le poste de secours. Imaginer une ligne perpendiculaire au poste, du mur Ouest de ce dernier jusqu'à la mer. Cette ligne
5 – Passer derrière le poste de secours et se rendre au milieu de l'aire de stationnement.	Compter les différents usagers (des plagistes essentiellement) et les véhicules stationnés sur l'aire.
6 – Une fois le comptage de l'aire de stationnement terminé, retourner au point du rivage où le comptage a été stoppé, juste avant le poste de secours, puis longer à nouveau le rivage vers l'Est.	Continuer à compter les différents usages en mer et sur la plage au fur et à mesure.
7 – S'arrêter au niveau de l'alignement entre les deux poteaux en bois plantés en arrière-plage, environ 1 km après le début du secteur naturiste de la plage.	A l'aide des jumelles, comptabiliser les usages en mer et à terre jusqu'à la limite Est de la zone, qui suit à peu près la crête de la plage de l'estuaire. Cette limite correspond à la ligne d'horizon lorsque l'on observe à partir de ce point. Ne pas hésiter à s'avancer davantage si un usage est difficile à déterminer à cette distance.
8 – Retourner au véhicule.	Ne rien comptabiliser lors de cette étape.

Evaluation of recreational fishing site use and effort through visual census from the shore / land

© GIS Posidonie

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Notify recreational fishers associations and federations
- Identify sectors and periods of activity to implement the sampling strategy

REMARKS

The count estimate will not provide accurate information on the activities carried out, the fishing effort associated with a specific gear or practice, if the fisher is too far away, in particular the fishing time of the counted gear. Other protocols must be used for this.

ACTIVITIES CONCERNED

Shore fishing, on foot, underwater, on board

Depending on the number of fishers, recreational and professional fishing can be counted at the same time

Objectives and expected results

Objectives

- Assess the use of the site by recreational fishers: the main activities carried out, their density in the MPA and their interaction with the resource and natural habitats
- Know the spatial (maps) and temporal (days, seasons, years) distribution of these sampling activities on site
- Identify illegal fishing activities
- Be able to superimpose this distribution with a habitat mapping (more difficult with this method because the position is less accurate than for boat or aerial counts)
- Better manage uses as part of a management plan, reduce conflicts
- Assess the means to be put in place to carry out awareness-raising actions
- Complete, if necessary, the data acquired by other protocols (surveys, counting from a boat, aerial surveys, fishing logbook, etc.)

Expected results

- Quantitative assessments (number of fishers, vessels, gear) and fishing effort
- Qualitative assessments of recreational fishing activities and practices (depending on the equipment of fishers, boats)
- Location of activities to understand interactions with habitats to implement appropriate management measures
- Quantitative and qualitative assessments of illegal fishing activities (see corresponding sheet)

Protocol description

- Three types of counting can be considered, and conducted in parallel:
  - monitoring of **site use at a specified time T, randomly repeated** over a defined period of time to take into account the spatial and temporal distribution and variability of the activity over the course of a year or a season
  - monitoring of **site use over a full day** from a fixed point to study the fluctuation in site use (peak use). This type of monitoring can be carried out at the beginning of the study to identify the appropriate times when use is optimal for a monitoring at a fixed time.
  - monitoring of **site use at a fixed time** (to be defined according to local practices), assumed to be the peak of use for the day.
- Counts from the coast are adapted to activities carried out near the shore (shore fishing, underwater hunting, collection), on sites offering good visibility. The method is applicable

SAMPLING: TIME UNITS

Monitoring periodicity

The protocol can be carried out throughout the year. If a period is to be preferred, choose the periods of maximum fishing activity

Frequency

1 count / week or every 2 weeks, in the middle of the day

Duration

Variable according to the distance to be covered, the condition of the trails and the accessibility conditions

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around

Monitoring subunits

- Areas by management category: total, partial protection, regulation of certain fishing activities such as authorized/ prohibited underwater hunting, for example.
- Sub-areas determined by zoning

FEEDBACK FROM EXPERIENCE

- Camargue Regional Natural Park (FR)

for on-board fishing and underwater hunting from a boat if the coastal fringe is limited (e. g. closed bay, gully), with good visibility (good weather conditions). Nevertheless, the information collected will be limited (e.g. number of boats fishing, number of people - be careful, not all people are necessarily fishers - number and type of fishing gear).

Whenever possible, counts can be carried out from a semaphore, which makes it possible to obtain the precise location of the boats thanks to radar control and to characterise the type of fishing using a pair of binoculars. All high points of view can also be used.

- Information to be collected from the coast:
  - Information on the site and the day's conditions:
    - trip date, operator, specific sectors / areas (in case of zoning, use of a recommended map), counting time on the area in question, weather conditions
  - Counting of fishers:
    - total number of fishers per site / area of fishing, number of surface buoys (underwater hunter), total number of vessels (on-board fishing), number of fishers per vessel (on-board fishing)
    - type, size of boat, anchored or drifting boat (on-board fishing, underwater hunting)
    - number of fishers by type of fishery and gear and number of gear (if visible)
    - distinction between adult / child fishers
  - Additional information:
    - other users met (number of people and / or boats per site, by type of activity)
    - GPS positions when tracking allows you to be close to fishers
    - observation of fishing in prohibited areas

Implementation advice

- A count sheet must be created before the protocol is implemented. This model should always be used during trips (to avoid omissions and errors in the notation of information).
- The counting sheet can be in paper or digital format on a tactile tablet (see models IODDE-VIVARMOR, Littorea network or LIFE pêche à pieds).
- It is advisable to describe the protocol in detail for teams likely to implement it
- A zoning must be established prior to the implementation of the protocol, limited by geomorphological markers that can be easily identified in the field (capes, islets, structures, ports). This facilitates field work and avoids losing a trip in the event of GPS failure or omission or satellite reception problems.
- It is essential to sample also outside the managed areas in order to measure the effectiveness of management measures.
- The entire count must be carried out at the same time of day in a minimum of time covering the whole study area (the objective is to obtain a snapshot of the fishing activities).
- The recommended period is rather the morning if the activity is not known (the majority of fishers work in the morning), but this must be adjusted according to local practices and targeted métiers.
- When counting from land, the entry and exit times must be recorded for each zone crossed. Each observed activity should only be counted when the agent carrying out the counting reaches its level. This avoids double counting, as well as the assignment of a use in an inaccurate area. A user located from a distance whose activity is not clearly determined may sometimes force the agent to leave his itinerary in order to get closer to acquire more precision. This observation ability is unique to each agent. In order not to waste time, the defined routes incorporate viewpoints from which the extremities of each area can be observed with sufficient clarity. However, it is important to reduce the counting time on each zone, in order to have precise data over time on each monitored zone.
- For large MPAs, several people can be mobilised at the same time to take a photograph of the site at a given time. Beware of duplicates in the counts: a precise breakdown is necessary and a clear distribution of the sectors / zones of each team.

- If inexperienced people are mobilised (students on internships, volunteers), training must be provided to distinguish between different activities, practices and users. These people should be accompanied on their first field trips.
- Regardless of the experience of the counters, 1 or 2 calibration trips are required to get familiar with the protocol and harmonise the procedure. Do not hesitate to renew regularly.

Difficulties, advantages / Disadvantages

- Needed human resources can be significant, depending on the degree of precision and the desired frequency
- The effort is significant during the acquisition period but the data obtained will be quantitatively and spatially accurate and the typology of activity is found seasonally

Advantages

- Good accuracy on the location of fishing activities on the coast
- No need for resources at sea and therefore less expensive
- From a high point: hill, semaphore, lighthouse, etc. the visibility of fishing gear (= surface signals) is better
- The method makes it possible to avoid weather-related problems (except during intense fog)

Disadvantages

- Requires good visibility and a good sense of observation
- Lack of precision on the location of deployed fishing gear
- Identification of underwater hunters more complex (underwater, therefore not very visible)

Material

- GPS and / or zoning map
- Pair of binoculars
- Counting sheet maintained on a slate

€ Estimated costs (€: low, €€: medium, €€€: high)

€€€	Human resources (help from internship students and / or volunteers can reduce costs)
0	Specific service for data collection
€	Investment / material + touch pad if digital format
€€	Data analysis

Administrative procedures, legal provisions

- Administrative authorisations required to access restricted areas (routes through private property, military areas, etc.)
- If possible access to a semaphore: authorisations / access agreements with the relevant authorities

Type of results obtained / Metrics

- Basic metrics by activity :
  - number of boats
  - number of fishers

- number of fishers per vessel
- number of gear per fisher
- number of illegal fishing acts

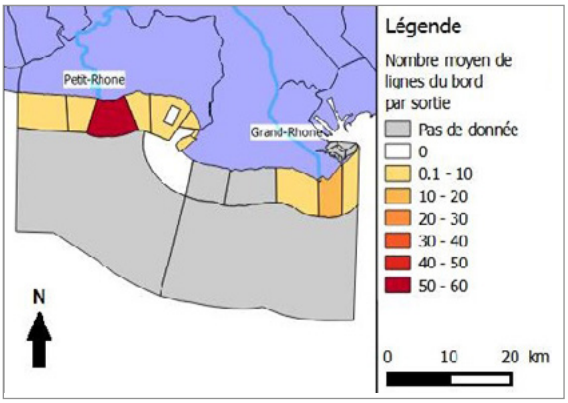
- Derived metrics:
  - average number of boats / sector / season or per year
  - average number of fishers / sector / season or per year
  - average number of fishers per vessel / sector / season or per year
  - average number of gear per fisher / sector / season or per year
  - average number of illegal fishing acts / sector / season or per year

Graphical representations

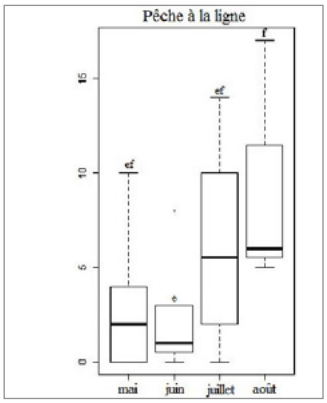
- Tables, histogrammes of site use by temporal (day, season, year) and spatial (sector / area) variables
- Maps showing the distribution of fishing activities, fishing gear deployed and their intensity in terms of site use

To go further

- Chalard, 2017. Mise en place d'un suivi de la fréquentation en mer et sur le littoral en Camargue. Rapport de stage Master 2, Aix-Marseille Université, Parc naturel Régional de Camargue, GIS Posidonie, MIO. 35 p. + appendices
- Gamp *et al.*, 2016. Pêche récréative: un guide pour vous orienter dans vos méthodes de suivis – Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des aires marines protégées, Fr.: 199 p.
- Privat *et al.*, 2013Etude et diagnostic de l'activité de pêche à pied récréative: cahier méthodologique et recueil d'expériences. CPIE Marennes Oléron et VivArmor Nature, 138 p. + appendices
- Privat, *et al.*, 2018. Etude et caractérisation de la pêche à pieds récréative. Cahier méthodologique. 297 p.
- Verbeke *et al.*, 2013. La gestion de la pêche de loisir dans les aires marines protégées. Recueil d'expériences des gestionnaires. ATEN, coll « Cahiers techniques » n°87: 112 p.
- VivArmor Nature, 2012. La pêche à pied récréative dans les Côtes d'Armor. Rapport final du Contrat Nature " Gestion durable de l'activité récréative de pêche à pied et préservation de la biodiversité littorale ". 215 p.



Distribution of shoreline and underwater hunting activities in the Natura 2000 Camargue site (PNR Camargue-GIS Posidonie, 2017)



Monthly evolution of the number of anglers recorded on the coast of the Natura 2000 Camargue site (PNR Camargue-GIS Posidonie, 2017)

Example of a foot-based fishers counting sheet adaptable to the Mediterranean (Privat *et al.*, 2013).

Annexe 1 : Exemple de feuille de comptage

Comptage du : .....
Observateur(s) : .....
Conditions météorologiques.....
.....

Heure : ..... Site : .....

Type d'estran : ..... Secteur : .....

Résultats comptage :

	Pêcheurs en place	Pêcheurs en déplacement	
		Arrivées	Départs
Parking			
Zone 1 (près de la plage)			
Zone 2 (milieu d'estran)			
Zone 3 (bord de mer)			
Zone 4 (zone subtidale proche)			
Total			

Espèces péchées :

Pêches sur des concessions conchylicoles :

Oui Non Sans Objet

Autres activités sur le site: Professionnelles (conchyliculture / autre) : .....
Loisir : .....

Remarques :
(notamment présence d'oiseaux : espèces effectifs, distance aux pêcheurs, comportement)

Heure : ..... Site : .....

Type d'estran : ..... Secteur : .....

Résultats comptage :

	Pêcheurs en place	Pêcheurs en déplacement	
		Arrivées	Départs
Parking			
Zone 1 (près de la plage)			
Zone 2 (milieu d'estran)			
Zone 3 (bord de mer)			
Zone 4 (zone subtidale proche)			
Total			

Espèces péchées :

Pêches sur des concessions conchylicoles :

Oui Non Sans Objet

Autres activités sur le site: Professionnelles (conchyliculture / autre) : .....
Loisir : .....

Remarques :
(notamment présence d'oiseaux : espèces effectifs, distance aux pêcheurs, comportement)

Evaluation of professional and recreational fishing site use and effort through aerial counting

© MedOBS

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Good weather, good visibility
- Take into account the sectors and periods of activity but also the nesting of birds to implement the sampling strategy

REMARKS

The count estimate will not provide precise information on the métiers practised, the fishing effort associated with a specific gear or practice, in particular the fishing time of the counted gear. Other protocols must be used for this

ACTIVITIES CONCERNED

All of them, whether professional or recreational. For small coastal métiers, the distinction between gear (nets, longlines and traps) is impossible except for stationary traps, the consideration will be global

Objectives and expected results

Objectives

- Assess the use of the site by professional and recreational fishers: the main activities carried out, their density in the MPA and their interaction with the resource and natural habitats
- Know the spatial (maps) and temporal (days, seasons, years) distribution of these sampling activities on site
- Identify illegal fishing activities
- Be able to superimpose this distribution with a habitat mapping
- Better manage uses as part of a management plan, reduce conflicts
- Assess the means to be put in place to carry out awareness-raising actions
- Complete, if necessary, the data acquired by other protocols (surveys, counting from a boat, from the coast, fishing logbook, etc.)

Expected results

- Quantitative assessments (number of gear, boats, fishers) and effort
- Qualitative assessments of professional and recreational fishing activities and practices (depending on the equipment of the vessels, fishers)
- Location of activities to understand interactions with habitats to implement appropriate management measures
- Quantitative and qualitative assessments of illegal fishing activities (see corresponding sheet)

Protocol description

- Several technologies are available for flight vehicles: aircraft, helicopter, ULM (Ultra Light Motorised), drone, captive balloon, kite, etc.
- A flight plan is prepared. The count must be reproduced according to the same flight plan.
- The counting can be carried out directly by an on-board observer, or indirectly by using photographs (vertical or oblique) or videos taken during overflights.
- This choice of counting is justified when the spatial scale is extended since it allows the area to be covered in a limited time. Similarly, when the site is very busy and the density of fishers makes sight counting difficult, if not impossible, to carry out. Vertical photographs make it possible to geo-locate observations, taking care to have fixed landmarks on the photographs.

SAMPLING: TIME UNITS

Period of maximum fishing activity or characteristic of the season

Monitoring periodicity

The protocol can be reproduced at each season or at the same season with a regular annual interval (every year, every 3 years)

Frequency

4 times a year, spread over March / April / May and August / September / October

Duration

Depending on the area to be covered, the flight plan

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around

FEEDBACK FROM EXPERIENCE

- Iroise Marine Natural Park (F) http://www.parc-marin-iroise.fr/
- Mediterranean Air Observatory MEDOB) https://www.medobs.fr/

- Information to be collected by aerial counting:
  - Information on the site and the day's conditions:
    - trip date, operator, flight plan, specific sectors / areas (in case of zoning, use of a map is recommended), time slot for counting on the area in question, weather conditions
  - Counting of fishers:
    - professional and recreational fishers identification (when visible), total number of fishers per site / area of fishing, number of surface buoys (pre-professional fishing gear, buoys on coral or sponge fishing sites, underwater fisher), total number of boats (professional fishing, onboard, underwater hunting), number of fishers per boat (professional fishing, onboard, underwater fishing)
    - type, estimation of boat size, anchored or drifting boat (professional fishing, on-board, underwater fishing)
    - number of fishers by type of fishing and by gear; the number of gear may be difficult to observe depending on the shooting conditions / photo resolution (sea and coastal fishing)
  - Additional information:
    - other users met (number of people and / or boats per site, by type of activity) if visible
    - GPS positions when the means implemented allow it
    - observation of fishing in prohibited areas, illegal practices

Implementation advice

- A counting sheet must be created before the protocol is implemented. This model should always be used during trips (to avoid omissions and errors in the notation of information).
- The counting sheet can be in paper or digital format on a touch pad.
- If there are no geolocation means implemented, it is necessary to establish a zoning prior to the implementation of the protocol. It is advisable to use geomorphological markers that can be easily identified in the field (capes, islets, structures, ports)
- It is essential to sample also outside the managed areas in order to measure the effectiveness of management measures.
- A route can be set up to avoid having to count the same boats, gear twice and to optimise travel (and fuel costs)
- If inexperienced people are mobilised (students on internships, volunteers), training must be provided to distinguish between different activities, practices and users. These people must be accompanied on their first trip.
- Regardless of the experience of the counters, a calibration is required between the different counters. Do not hesitate to renew regularly.

Difficulties, advantages / Disadvantages

Advantages

- Precise location of boats, fishers, gear possible
- Coverage of large areas in a short period of time
- Counting in hard-to-reach areas
- If shots (photos / videos) are taken, then a visual memory of site use is built up; extremely reliable data but beware: large storage space is required
- If shots: keep abreast of ongoing computer developments in artificial intelligence-based image processing support
- For all uses at the same time

Disadvantages

- Airborne means that can be costly (importance of sharing with other monitoring, other MPAs to reduce costs)
- The use of aircrafts must comply with the navigation regulations in force in the country (civil and military aviation, overflights of inhabited areas, etc.)
- All activities (and uses) apprehended at the same time: high density in places that may be difficult to distinguish, to provide information
- Ideal weather conditions and pilot availability must match
- Limited flying times (no sun reverberation, impossible before sunrise and after sunset)
- Lack of precision on the fishing gear deployed (depending on the quality of view / shooting)
- Long shot analysis time: several days of analysis for 1 day in the field (automated processing tools are being developed)
- Preservation of birds, especially during nesting or wintering periods. Overflight may be prohibited at certain times of the year

Material

- If the use of photos/videos is chosen, it is important to invest in a digital camera with a resolution high enough to have a good image quality (minimum 12 million pixels)
- Overflight aircraft (pilot licence if applicable)
- GPS and / or zoning map
- Pair of binoculars,
- Counting sheet held on a scoreboard/scoring tablet

€ Estimated costs (€: low, €€: medium, €€€: high)

€ Human resources (help from internship students and / or volunteers can reduce costs)

€€€ Specific service for data collection (unless you buy a drone or kite)

€€€ Investment / material (including fuel €€) + touch pad if digital format

€€ Data analysis - direct observation

€€€ Data analysis - indirect observation indirecte (photos/videos)

Administrative procedures, legal provisions

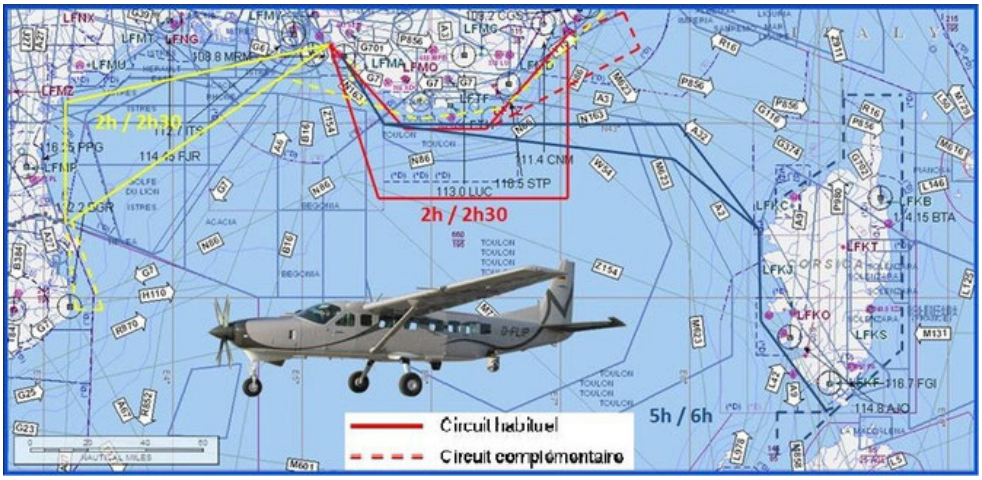
- Administrative authorisations required for overflight (flight plan, authorisation to access forbidden areas, etc.)
- Up-to-date pilot and overflight equipement licenses (if applicable)

Type of results obtained / Metrics

- Basic metrics:
  - number of recreational fishing activities
  - number of professional and recreational fishing vessels
  - number of gear
  - number of illegal fishing acts
- Derived metrics:
  - average number of activities / sector / season or per year
  - average number of boats / sector / season or per year
  - average number of gear / sector / season or per year
  - average number of illegal fishing acts / sector / season or per year

Graphical representations

- Tables, histogrammes of site use by temporal (day, season, year) and spatial (sector / area) variables
- Maps of the distribution of activities, boats, professional and recreational fishing gear and their intensity in terms of site use



Aerial routes carried out for the monitoring of the French Mediterranean coast as part of the MEDOBS Observatory

The flights are carried out randomly (days of low and high attendance), in order to have data sets representative of the average situation

To go further

- Gamp *et al.*, 2016. Pêche récréative: un guide pour vous orienter dans vos méthodes de suivis – Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des aires marines protégées, Fr.: 199 p.
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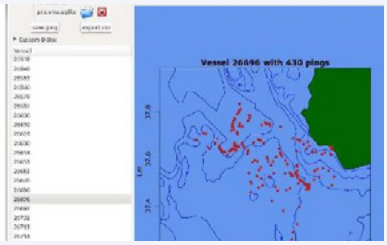
Site use counts / Fishing effort

Evaluation of professional fishing site use and effort by satellite-based vessel monitoring system



© Russo *et al.* 2014

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Adequate equipment for professional fishing vessels (obligation or cooperation)
- Professional fishing regulations in force on the site

REMARKS

The estimation of the routes followed by vessels will not provide accurate information on the fishing effort associated with a specific gear or practice, in particular the fishing time of the counted gear. Other protocols must be used for this.

The data acquired will only concern vessels equipped with automatic identification and vessel monitoring systems

ACTIVITIES CONCERNED

All of them

Objectives and expected results

Objectives

- Assess the use of the site by professional fishers: the main activities carried out, including illegal activities, their densities in the MPA and their interaction with the resource and natural habitats
- Know the spatial (maps) and temporal (days, seasons, years) distribution of these sampling activities on site
- Identify illegal fishing activities
- Be able to superimpose this distribution with a habitat mapping
- Better manage uses as part of a management plan, reduce conflicts
- Assess the means to be put in place to carry out awareness-raising actions
- Supplement, where appropriate, the data acquired by other protocols (surveys, sea counts, aerial counts, fishing logbooks, etc.)

Expected results

- Quantitative assessments (number of vessels, by site, by period) and fishing effort
- Qualitative assessments of professional fishing activities (satellite data (VMS) must be cross-referenced with other declarative or survey data to determine the gear used)
- Location of activities to understand interactions with habitats and to implement appropriate management measures
- Quantitative and qualitative assessments of illegal fishing activities (see corresponding sheet)
- Surveillance assistance, compliance with no-fishing zones, dissuasion

Protocol description

- A fishing vessel monitoring system (VMS) is a real surveillance programme in which electronic equipment installed on board a vessel provides information on its position and activity: automatic identification system (AIS) and satellite vessel monitoring system (VMS). This equipment is permanently installed on board the vessel and has a unique identifier. Satellite technologies are preferred because of their wide geographical coverage. A ground station receives and validates the information transmitted by the satellite, stores this data or retransmits it in real time, for example on an Internet application.

SAMPLING: TIME UNITS

Period of maximum fishing activity or characteristic of the season

Monitoring periodicity

The protocol can be reproduced at each season or at the same season with a regular annual interval (every year, every 3 years)

Frequency

1 check / day to be carried out at key periods of the fishing season or the targeted activity or complete monitoring of the trip

Duration

Depending on available time and fishing intensity

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around

Monitoring subunits

- Areas by management category: total, partial protection, regulation of certain fishing activities
- Sub-areas determined by zoning

FEEDBACK FROM EXPERIENCE

- Côte Bleue Marine Park (FR)
- Camargue Regional Natural Park (FR)

- Fishing vessel tracks are visible online 24 hours a day (example in France of Marine Traffic); they can be recorded and make it possible to locate, monitor and count the activity of vessels over 12 m in size.
- The method is valid for relatively large vessels and métiers carried out far from the coast (number of vessels and GPS tracking of their trail) but also near the shore, MPAs subjected to trawling or shore purse seine (lamparos) pressure. It can be used to cover large areas.
- These counts are not dependent on weather conditions, in particular sea conditions, and do not involve equipping the MPA with ships to go out to sea.
- The method is also designed to discourage coastal trawling (e.g. the 3 mile strip in France).
- Information to be collected:
  - number of ships by activity and directions taken by the ships according to the conditions of the day
  - trip date, weather conditions, sectors / zones and GPS plot time, slot for monitoring the area in question
  - number of gear per site / fishing area/period
  - type of activity observed (trawl / purse seine)

Implementation advice

- Data consultations must be carried out at different times of day to better understand the fishing activity. The recommended period is rather the early morning if the activity is not known (the majority of fishers work in the morning), but it must be adjusted according to local practices and targeted métiers. VMS data show the tracings of the vessels' movements but do not specify where the fishing actions take place. This requires algorithms to process these data in order to try to identify them as effectively as possible (e.g. reducing travel speed).
- Most systems allow you to consult the course of ships at night or on previous days. It is advisable to regularly consult the dedicated sites and to entrust this monitoring task to a person from the MPA. Maps can be printed and used for management meetings.
- The same satellite technologies that have contributed to the increase in fishing effort in places and the decline of some stocks are now becoming one of the tools available to fisheries managers and managers to achieve sustainable fishing.
- This methodology is complementary to monitoring at sea, regulating access to certain areas reserved for licensed vessels, restrictions on fishing gear or the duration of fishing, quotas fixing the quantity of particular species that can be fished, etc. VMS data as such are not sufficient, it is useful to cross-reference different sources of information.
- Data collection may also include catch collection in major fisheries. Catch data and other data related to fishing activities, such as reports on a vessel's intentions, may also have a related regulatory compliance function. For example, catch reports can be used to monitor a catch quota.

Difficulties, advantages / Disadvantages

The effort is significant during the acquisition period but the data obtained will be quantitatively and spatially accurate and the typology of activity is found seasonally.

Advantages

- Accuracy of location thanks to GPS positioning and vessel activity, without disturbing fishers
- No technical qualification required, but this method is becoming more widespread in the western Mediterranean
- The data is available online at any time and the maps usable
- Allows to cover the entire MPA and around it

Disadvantages

- The implementation of the satellite-based vessel monitoring system is dependent on the availability of technological means at an affordable price in a fishing area
- Difficulty in distinguishing whether the vessel is fishing or in transit
- The system can be disconnected on board and interrupted tracks are detected in sensitive areas

Material

- Computer with internet access

€ Estimated costs (€: low, €€: medium, €€€: high)

€ Human resources (help from internship students and / or volunteers can reduce costs)
0 Specific service for data collection
€ Investment / material
€ Data analysis

Administrative procedures, legal provisions

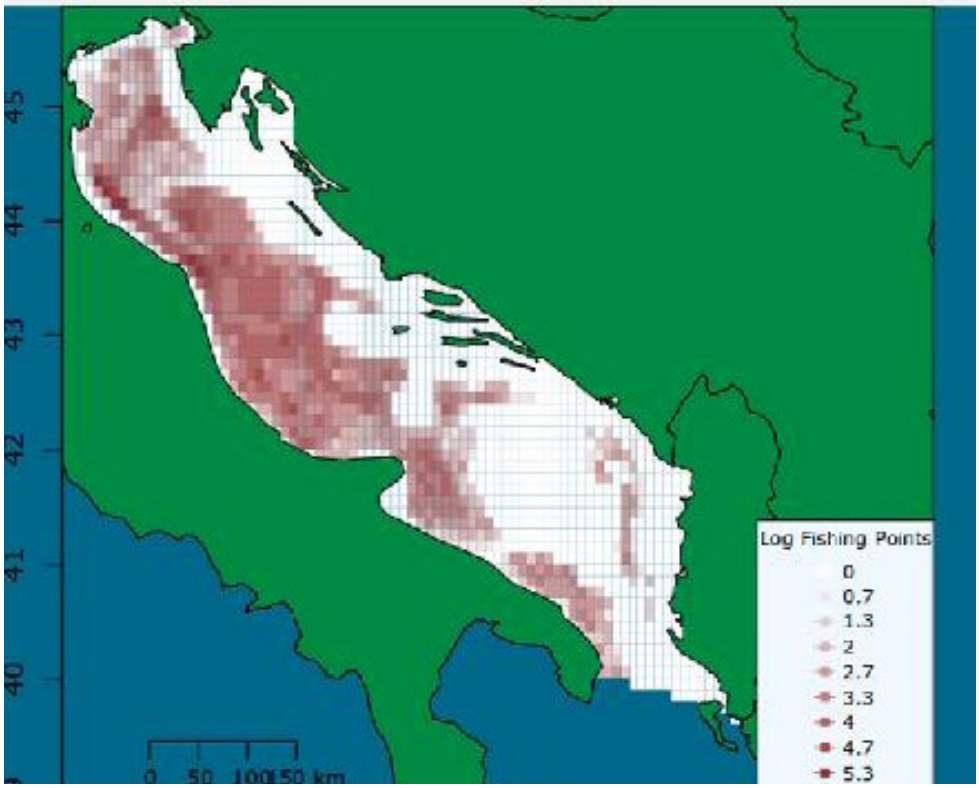
- Plan to collaborate with national structures to recover and use data (convention etc.)

Type of results obtained / Metrics

- Fishing effort maps based on the distribution of fishing vessels and fishing trawls
- Basic metrics:
  - number of professional fishing vessels
  - number of fishing trawls
  - port of origin of vessels operating in the area and métier
  - number of fishing vessels in illegal action
- Derived metrics:
  - average number of professional fishing vessels per sector / season or per year
  - average number of fishing trawls per sector / season or per year
  - average number of fishing vessels in illegal action / sector / season or per year

Graphical representations

- Tables, histogrammes of site use by temporal (day, season, year) and spatial (sector / area) variables
- Maps of distribution of professional fishing gear
- Fishing intensity maps from gear density



Fishing effort allocation grid for vessels equipped with VMS in the Adriatic Sea (Russo *et al.*, 2014)

To go further

- Murawski *et al.*, 2005. Effort distribution and catch patterns adjacent to temperate MPAs. ICES Journal of Marine Science, Volume 62, Issue 6, 2005, Pages 1150–1167, https://doi.org/10.1016/j.icesjms.2005.04.005
- Russo *et al.*, 2014. VMSbase: An R-package for VMS and Logbook Data Management and Analysis in Fisheries Ecology. PLoS ONE 9(6): e100195. doi:10.1371/journal.pone.0100195
- Russo *et al.*, 2016. Modeling landings profiles of fishing vessels: An application of Self-Organizing Maps to VMS and logbook data. Fisheries Research 181: 34-47.
- Witt *et al.*, 2007. A Step Towards Seascape Scale Conservation: Using Vessel Monitoring Systems (VMS) to Map Fishing Activity. PLoS ONE 2(10): e1111. doi:10.1371/journal.pone.0001111
- http://globalfishingwatch.org/
- https://www.ted.com/talks/enric_sala_let_s_turn_the_high_seas_into_the_world_s_largest_nature_reserve

Evaluation of professional and recreational fishing site use and effort using the photographic method

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

Identify sectors and periods of activity to implement the sampling strategy

REMARKS

The count estimation will not provide precise information on the métiers and activities carried out. Other protocols must be used for this.

ACTIVITIES CONCERNED

All of them, whether professional or recreational. For small coastal métiers in professional fishing such as nets, longlines and traps, the distinction is not always possible (depends on the location of the gear and the quality of the cameras)

Objectives and expected results

Objectives

- Assess the use of the site by professional and recreational fishers: the main activities carried out, their density in the MPA and their interaction with the resource and natural habitats
- Know the spatial (maps) and temporal distribution (days, seasons, years) of these sampling activities on site (days, seasons, years)
- Determine the residence times (if several shots at regular time intervals), the gear identified
- Identify illegal fishing activities
- Be able to superimpose this distribution with a habitat mapping
- Better manage uses as part of a management plan, reduce conflicts
- Assess the means to be put in place to carry out awareness-raising actions
- Complete, if necessary, the data acquired with other protocols (surveys, counting from a boat, aerial counts, fishing logbook, etc.)

Expected results

- Quantitative assessments (number of boats, fishers, gear, length of time on each site)
- Qualitative assessments of professional and recreational fishing activities and practices (depending on the equipment of the vessels, the fishers, if the photo resolution is good)
- Location of activities to understand interactions with habitats to implement appropriate management measures
- Quantitative and qualitative assessments of illegal fishing activities (see corresponding sheet)

Protocol description

- This protocol was developed for recreational boating but is applicable to professional and recreational fishing.
- One (or more) camera with automated triggering is deployed on a suitable point of view (high on a cliff, on a building), hidden away from view. The entire device is installed in a waterproof and insulated housing to protect it from humidity and limit temperature variations. A wooden box (marine plywood recommended) with a glass (glass or plexiglass) on the lens side and lined with thermal insulation is perfectly suitable. Consider camouflaging it with paint or something else.

SAMPLING: TIME UNITS

Monitoring periodicity

The protocol can be carried out throughout the year. If a period is to be preferred, choose the periods of maximum fishing activity

Frequency

- Photographic shoots between 10 min and 1 hour (to be defined with scientists).
- Recharging batteries and changing memory cards every 10 to 15 days depending on the autonomy

Duration

- For the analysis of the photos: several months.
- For maintenance: variable according to the distance to be covered, the condition of the trails and the accessibility conditions

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA

Monitoring subunits

- Zones by management category: total, partial protection, regulation of certain fishing activities

FEEDBACK FROM EXPERIENCE

- Calanques National Park (FR)
- Scandola Marine Nature Reserve (FR)

- The device includes a reflex camera equipped with a very wide angle lens (usually 8 to 10 mm fish eye type) to cover a wide range (close to 180°), to be adapted according to the desired sampling surface and the location of the camera. The angle of view is centered on an area of interest that you want to study (see section "Sampling spatial units").
- The device is also equipped with an electronic system comprising:
  - a clock, with at least 20 programmable time slots, to turn on the camera. Remember to set the time
  - a pre-programmed (modifiable) interval meter with several possible interval ranges (from 5 to 30 minutes, etc.). An acquisition stop is recommended for the night in order to optimise the autonomy of the devices
  - a special power handle to power the camera on an external battery
  - an electronic voltage regulation box
- The photographs are integrated into a GIS (Geographic Information System). Each boat is marked by a line, drawn from bow to stern; each gear and each fisher is marked by a point. Each line / point has a unique identifier that allows each boat, gear or fisher to be clearly identified. As a result, this identifier is retained as soon as the boat, gear or fisher appears in the following photo. The unique identifier is used to monitor and analyse their spatial and temporal evolution, making it possible to evaluate the residence time of each boat, gear or fisher. If a boat is anchored, the anchoring position is determined from the centre of gravity (centroid) of all points representing the stern position.
- A matrix of points (with their GPS coordinates, latitude, longitude) is previously obtained in the field to geo-reference the photos (transformation of the oblique photo into an orthonormed photo), and especially the information they contain (such as the position of boats, fishing gear). This matrix is to be created at the time of installation of the automated trigger camera.
- Each event (unique identifier) identified on the photos is to be filled in as follows:
  - Information on the site and the day's conditions:
    - › operator, date, time of event, weather conditions
  - Counting of fishers:
    - › identification of vessels, gear (= surface signals), fishers
    - › if visible: the type of activity (passive or towed gear / gathering / underwater fishing / on-board fishing / walking)
  - Additional information (not required):
    - › other users met (by type of activity)

Implementation advice

- A procedure sheet must be created before the protocol is implemented. This sheet lists the various steps to be carried out during the maintenance trips of the device: changing the battery, memory card, cleaning the case glass, equipment to take with you (padlock wrench, screwdriver, etc.)
- An operation monitoring sheet is also created and includes the dates, times and purpose of each intervention (shutdown, battery change, photo discharge, restart) on each installed device
- Back at the office, all photos must be named and archived for further analysis
- Allow time for photo analysis, which is long

Difficulties, advantages / Disadvantages

Depending on the degree of precision and the desired frequency, the human resources needed for the analysis of photos and data can be important

Advantages

- Possible sampling from sunrise to sunset
- Precise location of fishers and gear
- vVisual archiving, you can come back to the data later

Disadvantages

- Long photo analysis time
- Risk of theft and / or vandalism or sabotage
- Obstruction from birds that can settle in front of the device

Material

- Camera with appropriate lens as appropriate (wide angle or not); provide a complete replacement set in case of failure
- Intervalometer, long battery life
- Wooden case, insulating
- GIS and computer software

€ Estimated costs (€: low, €€: medium, €€€: high)

€€€ Human resource (help from internship students and / or volunteers can reduce costs)

0 Specific service for data collection

€€ Investment / material

€€ Data analysis (help from internship students and / or volunteers can reduce costs)

Administrative procedures, legal provisions

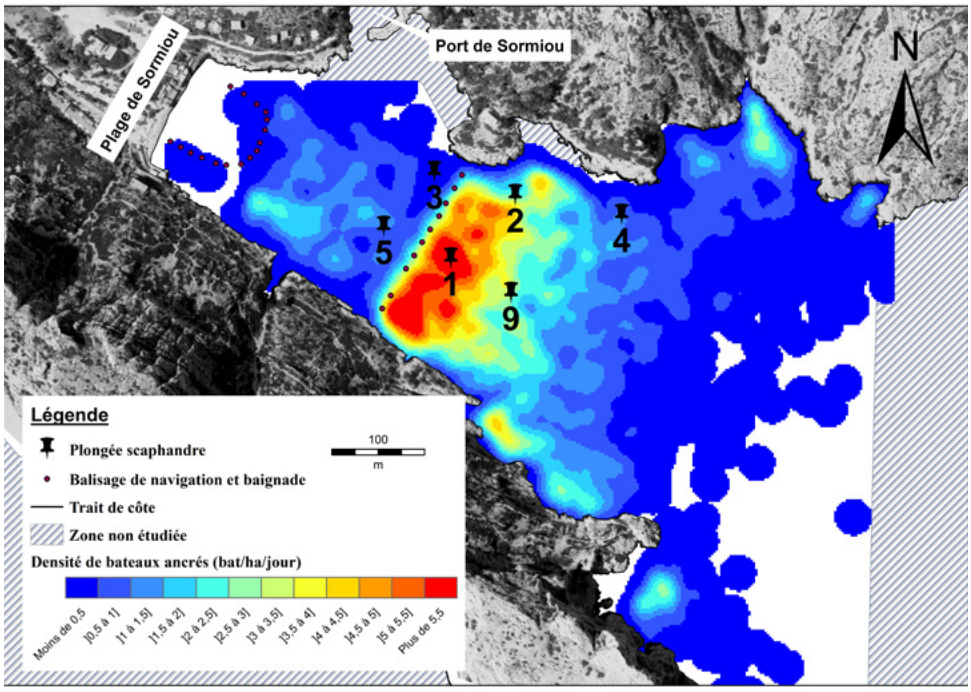
- Administrative authorisations required to access restricted access areas (routes through private property, military areas, etc.)
- Ensure compliance with the legislation in force relating to individual freedoms (photographs must not make it possible to recognise people on boats)

Type of results obtained / Metrics

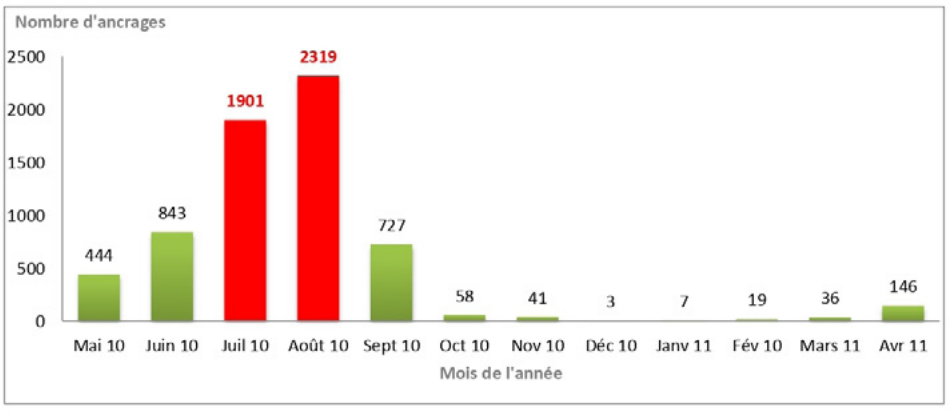
- Fishing effort maps based on the distribution of vessels or gear
- Basic metrics:
  - number of fishing vessels, fishers, gear
  - number of professional and recreational fishers
  - residence time
  - number of illegal fishing acts (presence during prohibited periods, for example)
- Derived metrics:
  - average number of fishing vessels, gear, fishers / sector / season or per year
  - average number of professional and recreational fishers / sector / season or per year
  - average fishing time / sector / season or per year
  - average number of illegal fishing acts / sector / season or per year

Graphical representations

- Tables, histogrammes of site use by time (residence time, day, season, year) and spatial (sector / area) variables
- Maps of the distribution of professional and recreational fishing effort and their intensity in terms of site use



Map of the densities (average number per ha/day) of boats anchored in the Sormiou cove from May 2010 to April 2011 (Frachon *et al.*, 2013)



Monthly distribution of boats anchored in the Sormiou cove from May 2010 to April 2011. Red: maximum values (Frachon *et al.*, 2013)

To go further

- Bonhomme *et al.*, 2013. A method for assessing anchoring pressure. Rapp. Comm. int. Mer Médit., 40: 845.
- Frachon *et al.*, 2013. Pleasure boat anchoring pressure in a Provence cove. Rapp. Comm. int. Mer Médit., 40: 846.

Identification of illegal fishing practices and poaching

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- The practice of fishing in the MPA must comply with national, regional, local and MPA-specific regulations
- Even if the MPA has not put in place any fisheries management actions
- Notify the authorities in charge of fisheries and customs police

REMARKS

Complex problem that can create conflicts with the inhabitants. Consider the possible consequences of collecting data on this subject that may be dangerous in some cases (trafficking and illegal activities related to police and customs missions)

ACTIVITIES CONCERNED

All of them (whether professional or recreational)

Objectives and expected results

Objectives

- To better understand illegal practices
- Assess poacher site use, number of poachers, periods when they are present in the MPA
- Identify the species targeted by illegal practices and the habitats that may be impacted
- Understand the quantities collected, note and date these evaluations (testimonies and reports can provide indications)
- Know the spatial (maps) and temporal (days, seasons, years) distribution of these illegal harvesting activities
- Be able to superimpose this distribution with a habitat mapping
- Find solutions to reduce and combat illegal practices in and around the MPA

Expected results

- Quantitative assessments (number of illegal fishing acts, gear, vessels, fishers with illegal activity)
- Qualitative assessments of illegal fishing activities and practices: fishing techniques and areas, species caught
- Be able to provide descriptive or even better, quantified information to fisheries and / or environmental police authorities to feed (where applicable) investigation files (practices, traffic patterns, identification of perpetrators, harmful facts, assessment of damage suffered, environmental damage, economic consequences, banditry networks), but also assessments at the Mediterranean level (GFCM).

Protocol description

- In this sheet, illegal fishing practices refer to:
  - fishing activity by national or foreign fishing vessels in maritime waters under the jurisdiction of a State, without the permission of that State or in violation of its laws and regulations (European Commission, Regulatory Council No 1005/2008); Article 3 (paragraph 1a) provides that a fishing vessel is presumed to be engaged in illegal, unreported and unregulated fishing if it is proved that it has fished without a valid licence
  - undeclared activities that often exploit the same areas, resources and professional fishing practices
  - recreational fishing activities replacing professional fishing by the sale of fishery products

SAMPLING: TIME UNITS

Monitoring periodicity

As days go by, illegal fishing acts, identified during the various site use monitoring, field trips, testimonies collected

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around

Monitoring subunits

- Management areas: full, partial protection, regulation of certain fishing activities

FEEDBACK FROM EXPERIENCE

- Calanques National Park (FR)

  - practices prohibited by national laws: trawling near the coast, dynamite fishing, protected species, non-compliance with fishing quotas
  - practices prohibited by the MPA management plan: no-take zones, species under regulation, biological rest, prohibited professional and recreational fishing gear, non-compliance with the characteristics of the gear subject to regulation (mesh, number of hooks, etc.)

- In order to properly identify illegal fishing practices, it is necessary to gather and understand the various laws and regulations regulating professional and recreational fishing at the national, regional and MPA levels. This applies to both authorised / forbidden métiers and fishing activities, as well as practices, fishing areas and seasons and authorised / forbidden species.
- The identification of illegal fishing activities is based on the various protocols for studying fishing frequency and effort, namely:
  - visual counts from a boat / at sea (see corresponding sheets)
  - visual counts from the shore / land (see corresponding sheets)
  - aerial counts (see corresponding sheet)
  - the monitoring of professional fishing vessels by satellite (see corresponding sheet).
- The identification of illegal fishing acts is also based on the:
  - observations by MPA officers during their field trips on the MPA territory. These trips include surveillance tours as well as information, monitoring and accompaniment of external teams (scientists, other managers, elected officials, etc.). Officers may have a report card enabling them to enter the nature of the illegal fishing act, the date and place; an observation box is provided to allow any other information deemed necessary to be noted. Notes are taken during the field trip, or upon returning to the office; this information is recorded in a register and archived (see point below)
  - the testimonies collected during the various meetings with users: stories, photos, videos. Similarly, this information is named, dated and located, then archived and distinguished
- The various illegal fishing acts identified using the protocols mentioned above are collected and recorded in the same document or file. Consider making backups (paper and digital) that you will store in another location. Keep a low profile on this census.
- The fact of recording and dating even qualitative information makes it possible to create a file containing as much information as possible and evolving trends that the MPA is able to collect on its own means. Currently, catch estimates in the Mediterranean are largely underestimated for various reasons and it is now becoming necessary to assess this illegal fishing 'black box'.

Implementation advice

- Partner with the relevant police authorities (fisheries, environmental police, customs)
- Seek legal advice on the validity of proceedings and exhibits (which are valid in the event of legal proceedings)
- Take every precaution to ensure safety. Illegal acts may be under the management of illegal or mafia organisations. This work of identifying illegal fishing practices and poaching can be seen as a hindrance to their activities

Difficulties, advantages / Disadvantages

Advantages

- This census is mainly conducted at the same time as the various protocols for site use monitoring set up in the MPA. Requires little time and extra work. It can be done in complete discretion.
- The limited information collected can already be used (long-term work) to consider appropriate management measures to combat these illegal fisheries
- The fight against illegal fishing is a unifying objective for the managers and professional fishers of the area (shared interest to fight against)

Disadvantages

- Monitoring to be implemented in a considerate manner and in agreement with the authorities
- Exposure of managers in their fisheries policing role: requires swearing in. (Caution! It is difficult to carry out surveys among fishers if at the same time controls are being carried out on the same subject)
- The boundary between legal and illegal practices can be tenuous in some contexts, freeing oneself from bad local habits... so it is a long-term task.

Material

- For site use monitoring: see corresponding files
- For the census during the trips of MPA agents:
  - report sheet
  - binoculars
  - camera, video
- For the collection of testimonies:
  - audio and / or video recording medium
- In any case:
  - backup media (hard disk, cloud space, etc.)

€ Estimated costs (€: low, €€: medium, €€€: high)

€ Human resources
€ Specific service for data collection
€ Investment / material
€ Data analysis

Administrative procedures, legal provisions

- Ensure compliance with the laws in force in the country regarding census procedures and the validity of documents

Type of results obtained / Metrics

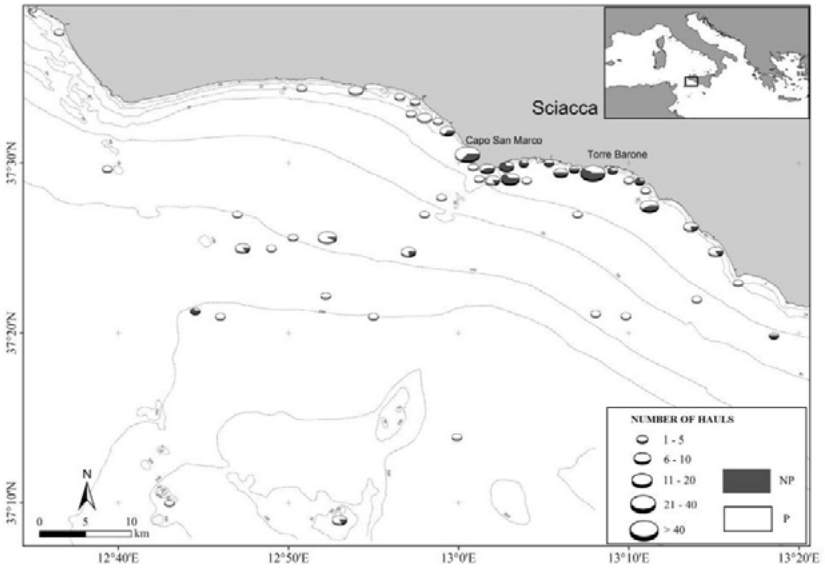
- Location and effort maps of illegal fishing activities
- Basic metrics :
  - number of illegal fishing acts
  - type of illegal fishing acts

(if trends are to be observed, the observation protocol, including the monitoring effort, must be identical over time)

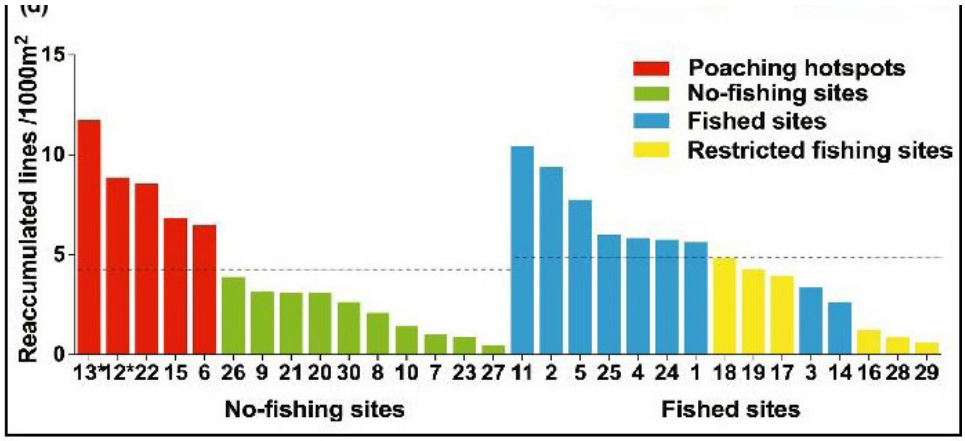
- Derived metrics :
  - average number of illegal fishing acts / sector / season or per year
  - type of illegal fishing activities / sector / season or by year

Graphical representations

- Tables, histogrammess of the frequency / occurrence of illegal fishing acts according to temporal (day, season, year) and spatial (sector / area) variables
- Distribution maps of illegal fishing acts



Mapping of areas visited by professional fishing vessels (P) and illegal professional fishing vessels (NP) (© Falautano *et al.*, 2018)



Density of fishing lines accumulated per 1000 m² recorded by visual counting on sites banned and authorized for recreational fishing (© Bergseth *et al.*, 2017)

To go further

- Bergseth *et al.*, 2017. A social-ecological approach to assessing and managing poaching by recreational fishers. Frontiers in Ecology and the Environment, 15(2): 67-73
- Cattaneo-Vietti *et al.*, 2007. Illegal ingegno fishery and conservation of deep red coral banks in the Sicily Channel (Mediterranean Sea). Aquatic Conservation: Marine and Freshwater Ecosystems, 27: 604–616.
- Davis *et al.*, 2004. Surveillance and Poaching on Inshore Reefs of the Great Barrier Reef Marine Park. Coastal Management, 32: 373-387.
- Falautano *et al.*, 2018. Characterization of artisanal fishery in a coastal area of the Strait of Sicily (Mediterranean Sea): Evaluation of legal and IUU fishing. Ocean and Coastal Management, 151: 77-91.

Assessment of catches and related recreational fishing effort through on-shore and at-sea surveys

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Have an idea of the composition of the parent population beforehand.
- The protocol can be conducted directly with the fisher or by telephone survey (in a less comprehensive manner)

REMARKS

The same questionnaire can be used to survey fishers with different types of activities: anglers and on-board, underwater hunters and fishers on foot (gathering)

ACTIVITIES CONCERNED

Shore fishing, on-board fishing, underwater hunting, gathering, sport fishing, offshore fishing, big game fishing

Objectives and expected results

Objectives

- Know the recreational fishing activities in the MPA: gear, techniques and practices, experience, periods in the year, etc.
- Know the reasons why fishers come to fish in or around the MPA
- Know the estimate that everyone makes of their annual catches in general and in the MPA
- Identify the factors that determine the diversity of behaviours observed: distribution within the MPA territory and periods of practice (seasons, day / night, peak hours)
- Identify hot spots and periods of high recreational fishing activity to guide management
- Identify target species and habitats potentially impacted by these activities
- Be able to define actions to be implemented to maintain these activities on a sustainable basis and avoid the most environmentally damaging behaviours
- Anticipate conflicts of use
- Evaluate the ownership and effectiveness of the management actions implemented

Expected results

- Typology of recreational fishing in and around the MPA
- Knowledge of target species
- Estimated catches per year and per trip
- Estimated yield per gear (CPUE)
- Identification of conflicting relationships

Protocol description

- The survey provides a better understanding of the respondent's recreational fishing practice: his experience, his habits. The questions should help to define fishers profiles (typology), hence the need to seek a good representation of the interviewees. This is a quantitative approach.
- The questionnaire consists of several sets of questions aimed at defining **the usual fishing practices and techniques** (number of trips per year, activity and usual gear), but also the **fishing activity of the day**: duration of the trip, gear used and possibly catches according to the fishing effort applied since the activity began. The results of this type of survey are a complement to the site use study that defines a number of boats, fishers and gear on the largest spatial scale.

SAMPLING: TIME UNITS

Monitoring periodicity

Every 3, 5 or 10 years depending on the observed evolution of activities

Frequency

As many surveys as possible during seasonal peaks; a minimum of off-season surveys

Duration

Tourist season or all year round, survey: 10-15 mins max per person

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around, if applicable, the different management areas

FEEDBACK FROM EXPERIENCE

- Cabo de Palos Marine Reserve (ES)
- Tabarca Marine Reserve (ES),
- Montgri, Iles Medes and Baix Ter Natural Park (ES),
- Cerbère-Banyuls Marine Natural Reserve (FR)
- Côte Bleue Marine Park (FR),
- Bouches de Bonifacio Natural Reserve (FR)

- The work of formulating and writing the questions is important and determines the quality of the results. During this phase, it is necessary to:
  - list the information to be collected
  - define how the questionnaire is to be administered
  - choose the format and content of the questions (MCQ, open-ended answers, etc.)
- These choices must be made taking into account the study and statistical analysis of the data, which must be anticipated.
- The number of people to be surveyed is to be defined with scientists who will assess the minimum sample size according to the intrinsic variability of the fishers' population (based on the parent population survey) so that the data are statistically representative. If not, do as much investigation as possible.
- The investigation may take place either during the fishing activity at the place of practice to make a simultaneous assessment of catches (to be avoided for underwater fishers), or outside the practice of the activity (in this case: no direct assessment of the day's catches) or when the fisher returns (which gives a complete picture of the catch of the trip).
- The answers depend in part on the form and order of the questions. Some recommendations can limit the effects of influence:
  - include a "no opinion" and / or "don't know" option
  - balance positive and negative modalities, avoid proposing a median modality (which will systematically seduce the undecided)
  - pay attention to the vocabulary and tone of the words used (avoid complicated, controversial, highly connotative words)
  - allow multiple responses, prioritising them to facilitate data processing
  - make sure that the wording of the questions does not guide the respondent's answer and choice, do not forget a "don't know" box
  - ask a key question in different ways to ensure that a precise answer can be obtained (cross-referencing of information)
  - start with simple and general questions before moving on to more technical questions.
- Each questionnaire must be written according to the objectives of the MPA, its resources, the available data and the characteristics of the site. An example well suited to shoreline and on-board fishing and underwater fishing is provided at the end of the sheet (PAMPA model questionnaire). For shellfish gathering, all the details are given in the methodological booklet on recreational fishing (Privat *et al.*, 2018).

Implementation advice

- Take into account in the sampling strategy the changes in population at the time of the tourist season
- Remember that respondents are on holidays or have come to relax, which implies people should be approached in a courteous manner and offered to participate in the survey
- The questions must follow one another in a fluid and instinctive way so that the survey does not last more than 10 minutes and gives way to 5 minutes of exchange and opportunity for the respondents to express themselves.
- For investigations at sea, it is more practical for a pilot to take care of the boat and for the investigator to conduct the dialogue with the fishers
- Taking the time to fine-tune the questionnaire very carefully is undoubtedly one of the keys to the success of this type of work
- Do not hesitate to do internal tests and repeat the survey to identify the sensitive points and necessary modifications before going into the field.
- Telephone surveys allow general questions to be asked to establish a typology of activity. It does not allow certain information to be verified: it is a declaratory mode of investigation. In particular, it does not allow to see the catches, to measure them and to weigh them precisely.

- This type of survey, which allows us to get to know the recreational fishers better, can be combined with a perception survey (opinion).
- The survey may or may not be accompanied by an estimate of catches with measurement and weighing of catches. The absence of catches should be recorded (zeros are important).
- Very good internship subject for students or volunteers. Surveys take time, seek for help

Difficulties, advantages / Disadvantages

Advantages

- Recommended face-to-face but can be conducted over the telephone
- Allows a large number of people to be interviewed
- No rewording of answers is necessary for close-ended or multiple-choice questions
- Easy and relatively fast data analysis
- Possibility to have perceptions in addition to typology and captures

Disadvantages

- Diversity of fishing activities and seasonality of catches involving a multiplication of surveys for each category of fisher and for each period
- High sampling effort: about 50 surveys per type of activity is a minimum for robust evaluations, even more so if a high profile variability was determined during the evaluation of the parent population (see corresponding sheet)
- Requires significant preparatory drafting work to be relevant (do not hesitate to ask for help and advice from specialists)

Material

- Questionnaire maintained on a rating board / tablet

€ Estimated costs (€: low, €€: medium, €€€: high)

€€	Human resources (help from internship students and / or volunteers can reduce costs)
0/€	Specific service for data collection (Internal / external)
-	Investment / material = means at sea for the monitoring of on-board fishing
€€	Data analysis

Administrative procedures, legal provisions

- If the person interviewed is a minor, the agreement and presence of at least one accompanying adult is required.

Type of results obtained / Metrics

- Practice metrics by activity:
  - number of fishers per surveyed vessel / group of fishers (shore fishing) by fishing activity
  - number of gear by gear type per vessel surveyed/fishers' group (on-board fishing)
  - duration of the day's trip (planned) by activity type
  - number of trips per year by type of activity
  - average declared duration of a fishing trip
  - number of years of practice of the activity

- Impact metrics by activity:
  - catches by spatial level for all species combined, a selection of families, target species
  - main species fished per year reported
  - CPUE for all species combined, for a selection of families, target species by spatial level

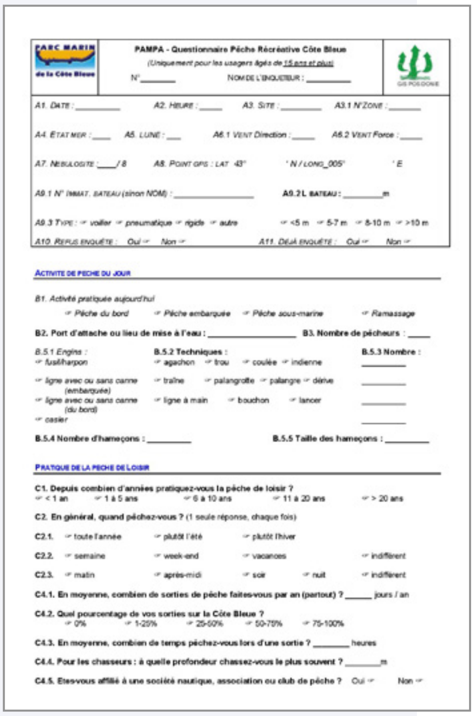
Graphical representations

- Tables, histogrammes of numbers, gear used, catches, CPUE, discards.

To go further

- Gamp *et al.*, 2016. Pêche récréative : un guide pour vous orienter dans vos méthodes de suivis – Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des Aires Marines Protégées, Fr. : 199 p.
- Privat *et al.*, 2018. Etude et caractérisation de la pêche à pieds récréative. Cahier méthodologique. Association IODDE, VivArmor Nature, AFB, 297 p.
- Rocklin *et al.*, 2014. Combining Telephone Surveys and Fishing Catches Self-Report: The French Sea Bass Recreational Fishery Assessment. PLoS ONE 9(1): e87271. doi:10.1371/journal.pone.0087271
- www.ifremer.fr/pampa
- www.um.es/empafish

Example of a questionnaire implemented in the Côte Bleue Marine Park as part of the PAMPA programme (Côte Bleue Marine Park and GIS Posidonie)


PARC MARIN de la Côte Bleue

PAMPA - Questionnaire Pêche Récréative Côte Bleue

(Uniquement pour les usagers âgés de 15 ans et plus)

N°______ NOM DE L'ENQUETEUR : ______

GIS POSIDONIE

A1. DATE : ______ A2. HEURE : ______ A3. SITE : ______ A3.1 N°ZONE : ______

A4. ETAT MER : ______ A5. LUNE : ______ A6.1 VENT Direction : ______ A6.2 VENT Force : ______

A7. NEBULOSITE : ____/8 A8. POINT GPS : LAT 43° ' N / LONG_005° ' E

A9.1 N° IMMAT. BATEAU (sinon NOM) : ______ A9.2 L BATEAU : ______m

A9.3 TYPE : voilier pneumatique rigide autre <5 m 5-7 m 8-10 m >10 m

A10. REFUS ENQUÊTE : Oui Non A11. DÉJÀ ENQUÊTÉ : Oui Non

ACTIVITE DE PECHE DU JOUR

B1. Activité pratiquée aujourd'hui

Pêche du bord Pêche embarquée Pêche sous-marine Ramassage

B2. Port d'attache ou lieu de mise à l'eau : ______ B3. Nombre de pêcheurs : ______

B.5.1 Engins : fusil/harpon; ligne avec ou sans canne (embarquée); ligne avec ou sans canne (du bord); casier

B.5.2 Techniques : agachon, trou, coulée, indienne; traîne, palangrotte, palangre, dérive; ligne à main, bouchon, lancer

B.5.3 Nombre : ______

B.5.4 Nombre d'hameçons : ______ B.5.5 Taille des hameçons : ______

PRATIQUE DE LA PECHE DE LOISIR

C1. Depuis combien d'années pratiquez-vous la pêche de loisir ?
< 1 an 1 à 5 ans 6 à 10 ans 11 à 20 ans > 20 ans

C2. En général, quand pêchez-vous ? (1 seule réponse, chaque fois)

C2.1. toute l'année plutôt l'été plutôt l'hiver

C2.2. semaine week-end vacances indifférent

C2.3. matin après-midi soir nuit indifférent

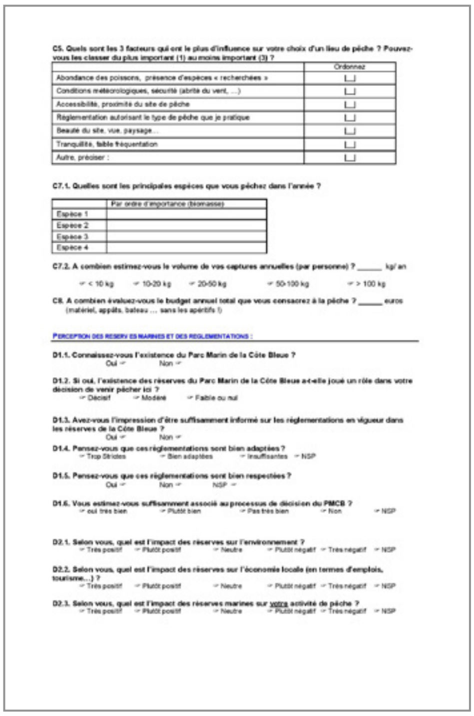
C4.1. En moyenne, combien de sorties de pêche faites-vous par an (partout) ? ______ jours / an

C4.2. Quel pourcentage de vos sorties sur la Côte Bleue ?
0% 1-25% 25-50% 50-75% 75-100%

C4.3. En moyenne, combien de temps pêchez-vous lors d'une sortie ? ______ heures

C4.4. Pour les chasseurs : à quelle profondeur chassez-vous le plus souvent ? ______m

C4.5. Etes-vous affilié à une société nautique, association ou club de pêche ? Oui Non


C5. Quels sont les 3 facteurs qui ont le plus d'influence sur votre choix d'un lieu de pêche ? Pouvez-vous les classer du plus important (1) au moins important (3) ?

	Ordonnez
Abondance des poissons, présence d'espèces « recherchées »	
Conditions météorologiques, sécurité (abrité du vent, ...)	
Accessibilité, proximité du site de pêche	
Réglementation autorisant le type de pêche que je pratique	
Beauté du site, vue, paysage...	
Tranquillité, faible fréquentation	
Autre, préciser :	

C7.1. Quelles sont les principales espèces que vous pêchez dans l'année ?

	Par ordre d'importance (biomasse)
Espèce 1	
Espèce 2	
Espèce 3	
Espèce 4	

C7.2. A combien estimez-vous le volume de vos captures annuelles (par personne) ? ______ kg/ an

< 10 kg 10-20 kg 20-50 kg 50-100 kg > 100 kg

C8. A combien évaluez-vous le budget annuel total que vous consacrez à la pêche ? ______ euros (matériel, appâts, bateau ... sans les apéritifs !)

PERCEPTION DES RESERVES MARINES ET DES REGLEMENTATIONS :

D1.1. Connaissez-vous l'existence du Parc Marin de la Côte Bleue ?
Oui Non

D1.2. Si oui, l'existence des réserves du Parc Marin de la Côte Bleue a-t-elle joué un rôle dans votre décision de venir pêcher ici ?
Décisif Modéré Faible ou nul

D1.3. Avez-vous l'impression d'être suffisamment informé sur les réglementations en vigueur dans les réserves de la Côte Bleue ?
Oui Non

D1.4. Pensez-vous que ces réglementations sont bien adaptées ?
Trop Strictes Bien adaptées Insuffisantes NSP

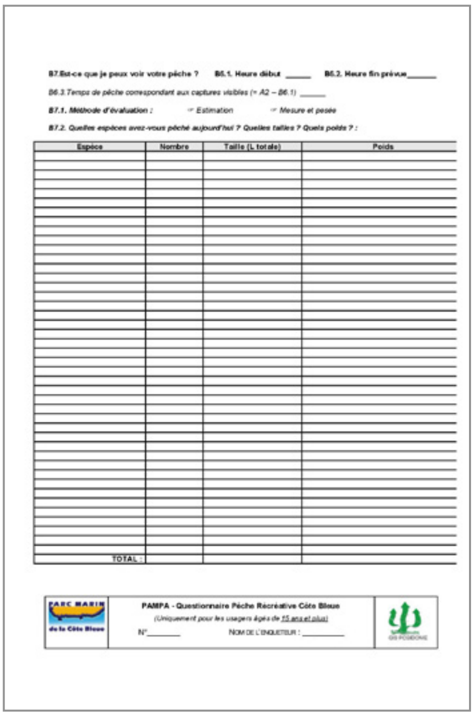
D1.5. Pensez-vous que ces réglementations sont bien respectées ?
Oui Non NSP

D1.6. Vous estimez-vous suffisamment associé au processus de décision du PMCB ?
oui très bien Plutôt bien Pas très bien Non NSP

D2.1. Selon vous, quel est l'impact des réserves sur l'environnement ?
Très positif Plutôt positif Neutre Plutôt négatif Très négatif NSP

D2.2. Selon vous, quel est l'impact des réserves sur l'économie locale (en termes d'emplois, tourisme...) ?
Très positif Plutôt positif Neutre Plutôt négatif Très négatif NSP

D2.3. Selon vous, quel est l'impact des réserves marines sur votre activité de pêche ?
Très positif Plutôt positif Neutre Plutôt négatif Très négatif NSP


B7.Est-ce que je peux voir votre pêche ? B6.1. Heure début ______ B6.2. Heure fin prévue______

B6.3.Temps de pêche correspondant aux captures visibles (= A2 – B6.1) ______

B7.1. Méthode d'évaluation : Estimation Mesure et pesée

B7.2. Quelles espèces avez-vous pêché aujourd'hui ? Quelles tailles ? Quels poids ? :

Espèce	Nombre	Taille (L totale)	Poids
TOTAL :			

PARC MARIN de la Côte Bleue

PAMPA - Questionnaire Pêche Récréative Côte Bleue

(Uniquement pour les usagers âgés de 15 ans et plus)

N°______ NOM DE L'ENQUETEUR : ______

GIS POSIDONIE

Evaluation of the activities of recreational fishing operators from interviews / surveys

© Location-bateaux 06

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Agreement of recreational fishing operators

REMARKS

Based on an interview with a representative of the recreational fishing company or association, this protocol aims to address and study several aspects of the activity. It will provide data on the description of the activity, site use of the MPA, catches made, economic impact and operators' perception

Distinguish this survey from the one that can be adapted to fishers boarded on the coast, sports fishers or big game fishers boarding with this type of operator (see sheet "Evaluation of effort and catches in recreational fishing" to be adapted to offshore fishing, if necessary)

ACTIVITIES CONCERNED

All of them, as long as there is a service provision

Mainly concerns offshore and deep-sea fishing, and to a lesser extent those who accompany fishers from shore, and inshore fishers (vessels, sea kayaks), whether or not they own them

Objectives and expected results

Objectives

- Evaluate the spatial and temporal site use by fishing charter operators: their presence frequency, density, location in the MPA
- Know the fishing techniques, fishing equipment used, species targeted / sought after and caught according to gear types and season;
- Assess the economic importance of near-shore and offshore fishing operators (big game fishing), identify the weight of market and non-market values
- Better manage uses as part of a management plan, reduce conflicts
- Assess the economic efficiency of the MPA: importance of this activity in the MPA, benefits and costs associated with the MPA (attractiveness of the MPA)
- Identify the factors that determine the diversity of behaviours observed: the process of land appropriation, acceptance, adherence or rejection of certain management measures
- Implement management actions by integrating their impacts on the activity: evaluation of economic impacts, constraints associated with certain measures
- Economic incentive to change the behaviour and mentalities of recreational fishers
- Assess the means to be put in place to carry out awareness-raising actions
- Complete, if necessary, the data acquired by other protocols (counting from the sea, the coast, aerial counting, fishing logbook, etc.)

Expected results

- Quantitative assessments (number of companies, associations, boats, guides, etc.) taking recreational fishers to sea per tour operator and spatial / temporal distribution
- Number of customers, assessment of fishing effort based on the number of trips, number of gear
- Qualitative assessments (species, number, biomass) of catches made
- Evaluation of practices and techniques and their evolution
- Identification of target / sought after species
- Evaluation of CPUE by activity, by gear category, taken from the site (days, seasons, years)
- Identification and quantitative assessment of the potential costs and benefits of the MPA
- Quantified and spatialised elements to implement appropriate management measures
- Understand how operators view the effects / impacts of their activity on the environment and the resource

SAMPLING: TIME UNITS

Frequency

When the MPA is set up or when the management plan is drafted, then updated every 5-10 years to take into account any changes in perception

Duration

1 h maximum

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPAs and attractiveness areas (see section 'Implementation advice')

FEEDBACK FROM EXPERIENCE

- MPA of Sinis and Maldiventre Island (IT)
- Columbretes Islands Marine Reserve (ES)
- Cabo de Palos Marine Reserve (ES)
- Medes Islands Marine Reserve (ES)
- Cerbère-Banyuls Nature Reserve (FR)
- Bonifacio Strait Marine Nature Reserve (FR)

- Know how they view the other actors in the MPA territory (other users, managers, decision-makers, associations, etc.): territories of practice, actual and / or potential conflicts, responsibilities, etc.
- Determine their knowledge of the regulations and the different management actions within the MPA: understanding, acceptance / rejection, effectiveness, legitimacy, suggestions

Protocol description

- The proposed protocol is intended to be compatible with limited means and adaptable to local means. The information is collected by interviewing recreational fishing operators (big game fishing, coastal or off shore on-board fishing, from the shore, in sea kayaks), but also independent fishing instructors (who do not necessarily have means at sea).
- An interview guide must be written beforehand. Its purpose is to structure the interrogation. It specifies the conceptual framework (who? why? etc.), how the interview should start, and lists the questions that are ordered by theme and sub-theme.
- The survey is conducted after an appointment has been made, at a time and place that is convenient for the interviewee.
- Information to be collected (for more details, see Alban *et al.*, 2006b):
  - Operator ID:
    - basic information: name of the company or association, legal status, date of creation, type of service offered, port of registry, number of boats and associated characteristics (length, tonnage, engine power, annual number of hours, year of construction, crew size), type of equipment, number of employees (including manager) permanent / seasonal, full time equivalent, experience in the field, age
  - Activity description:
    - period of activity in the year, number of trips per year, by type of equipment used,
    - type of trip (day, night, both), duration of trips (half-day, day, several days), proportion of trips in / out of the MPA
    - ancillary services (boat rental, underwater / free diving, whale-watching, etc.)
    - clients: proportion of residents / tourists, region of origin, profile (gender, age, experience, frequency of practice)
    - annual quantity of catches (the operator and his customers), proportion of catches made in the MPA, use of catches (sharing between customers, sale for own benefit, donations, others), main species caught (provide information for each the annual quantity, proportion taken in the MPA, price per kg).
  - Structure costs:
    - fixed costs: berth, boat maintenance, fishing gear, other
    - expenses or annual amount of gasoline and motor oil
    - variable costs: ice, bait, consumables (hooks, lures, lines, reels), food and drink for customers, various taxes.
  - Fishing areas:
    - number of sites in / outside the MPA, percentage of visits, duration of visits
    - localisattion in order of preference of the areas visited (e.g. zone 1 = x%, zone 2 = y%, etc.)
    - factors influencing the choice of fishing site: fish abundance, weather conditions, regulations, specific experience, safety, accessibility, proximity to the MPA, low attendance by fishers, other users
  - Influence of the MPA and link with fishing practice:
    - perceptions of the evolution of the state of the environment, the resource (species diversity, height / weight, number)
    - perceptions on governance, consultation, decision-making
    - perceptions on the regulation, zoning of the MPA
    - relations with other users, conflicts of use
    - formulated expectations
    - solutions to be proposed.

Implementation advice

- An interview sheet containing the various questions must be created before the protocol is implemented. This template should always be used during interviews (to avoid oversights and errors in rating information).
- It is important to sample operators who are based in the MPA but also in peripheral areas, as long as they come to the MPA territory (even if only occasionally). Peripheral areas can be extended, particularly in the case of big game fishing, and are linked to the navigational capacity of vessels and the attractiveness of the MPA in relation to sites outside. A preliminary study of the parent population (see corresponding sheet) is recommended before this protocol is carried out, in order to list the operators in an exhaustive way or to define a panel to which one will address oneself to carry out the interviews.
- It is important that the investigator guarantees the confidentiality of the data (anonymous and only in aggregated form).
- If inexperienced people are mobilised (students on internships, volunteers), training in knowledge of the different activities, fishing practices and survey methods should be provided. These people should be accompanied during their first interviews. Whatever the experience of the interviewers, 1 or 2 calibration interviews are necessary to get familiar with the protocol and gain fluency in the wording of the questions and the various exchanges. Do not hesitate to repeat regularly.

Difficulties, advantages / Disadvantages

- The recreational fishing operator's posture is not a priori the posture of his customers. Do not make any shortcuts or assimilations

Advantages

- Provides precise and detailed answers
- The time spent establishes a relationship of exchange and trust
- Provides information on what is happening in the offshore waters of the MPA (access may be difficult for MPA officers)
- Provides information on the presence of marine mammals, birds, turtles, present in offshore waters
- Allows you to go into the details of the ideas, the feelings of the interviewees

Disadvantages

- Requires significant preparatory drafting work to be relevant
- Long collection time, requires special skills if interviews are conducted
- Statistical approaches that may be complex, in particular with regard to economic aspects
- Long and tedious data analysis. Beware of misinterpretations. Possibly use experts (ecologist, economist, anthropologist, sociologist, geographer)
- Requires skills and know-how in interviewing techniques. If the manager has not been trained in these methods, he / she should be accompanied by competent persons during the construction of the survey.
- Perceptions only provide information on how reality is perceived by operators and not on their customers
- It is difficult to assess how much the income of fishing operators would change (and in which direction) if the area were not protected

Material

- Survey sheet on paper or scoring tablet
- Few materials required: listening staff to conduct surveys

€ Estimated costs (€: low, €€: medium, €€€: high)

€ Human resources (help from internship students and / or volunteers can reduce costs)

0/€€ Specific service for data collection (Internal/External)

€ Investment / material

€€ Data analysis. Use specialists (ecologist, economist) if possible

Administrative procedures, legal provisions

- If surveys / interviews are recorded, ask the interviewee for permission and ensure compliance with the legislation in force relating to individual freedoms.

Type of results obtained / Metrics

- Basic metrics:
  - number of operators, vessels
  - activity period
  - number of trips / activity type / year
  - number of trips in the MPA / activity type / year
  - list of species caught
  - quantity of samples / by species / type of activity / year
  - employment generated
  - knowledge of the existence of the MPA
  - advice on the level of information on the MPA
  - knowledge of fisheries regulations, of the MPA
- Derived metrics:
  - revenue / operator / year related to the MPA
  - average off-shore recreational fishing CPUE / year / boat
  - recreational fishing total catch on the coast, offshore, 'big game' fishing in the area

Graphical representations

- Tables, histogrammes of site use and catches by temporal (season, year) and spatial (sector / area) variables, socio-economic metrics and opinions
- Maps of site use, attractiveness area of the MPA

To go further

- Alban *et al.*, 2006. Methodological guidebook for Socio-Economic Field Surveys of MPA Users. Projet EMPAFISH, WP3, Deliverable 9. UBO, Brest, 38 p.
- Dell'Apa *et al.*, 2015. The North Carolina Charter Boat Fishery Changing with the Times: A Comparative Analysis of the Catch Composition (1978 and 2007–2008). Fisheries, 40: 223-233.
- Holland *et al.*, 1992. The U.S. Gulf of Mexico Charter Boat Industry: Activity Centers, Species Targeted, and Fisheries Management Opinions. Marine Fisheries Review, 54(2): 21-27.
- Roncin *et al.*, 2008. Uses of Ecosystem services provided by MPAs: How much do they impact the local economy? A Southern Europe perspective, Journal for Nature Conservation,16: 256-270.

Questionnaire for fisheries operators developed under the EMPAFISH programme (Alban *et al.*, 2006).

EMPAFISH Questionnaire for charter fishing operators

(Information about individuals will remain strictly confidential)

1. Date: _____
2. MPA name: _____

WHO ARE YOU?

3. Name of the fishing charter operator: _____
4. Date of establishment: _____
5. Legal status:
- ☐ Commercial business
- ☐ Non-profit organisation

6. Manager's name: _____
7. Year of birth: _____
8. When did you start this job: _____
9. Home port: _____

10. Number of jobs, including manager *(one line per person)*

	Nature of job	Full time or part time, as a % of a full time job	Wage earner? (Yes /No)	Number of months of work per year
Permanent	1.			
	2.			
	3.			
	4.			
Seasonal	1.			
	2.			
	3.			
	4.			

11. Is the skipper a wage earner? ☐ Yes ☐ No

12. How many boats do you run? _____

13. What are their technical characteristics?

Type of boat	Length (metres)	Tonnage (GT)	Engine power (kW)	Annual no. of engine operating hours	Year of construction	Year of purchase	Crew size	Max. no. of authorized passengers (not including crew)

14. According to your estimation, what is the present second hand market-value of your boat(s) and fishing gear? _____ €

15. Do you have the use of other premises or equipment?

Premises for customers	☐ Yes	☐ No	Buying ☐	Renting ☐	Size:
Premises to store equipments	☐ Yes	☐ No	Buying ☐	Renting ☐	Size:
Other (vehicles…)	☐ Yes	☐ No	Buying ☐	Renting ☐	

DESCRIPTION OF YOUR CHARTER ACTIVITY:

16. How many months of activity (linked to charter fishing) per year? _____

17. How many trips at sea do you organise a year? :

Number of trips per year	Number of customers per year	% of trips in the MPA (as a % of the total number of trips at sea)	Fare charged to customers (fare per trip)
			€

18. What are the main types of fishing gear?

Name of the gear	Number of trips / year	% of trips in the MPA (as a % of the total no. of trips)	Main targeted species

19. Average duration of a trip at sea (hours)?

When fishing inside the MPA	When fishing outside the MPA
_____hours	_____hours

20. What % of customers bring their own fishing equipment? _____%

21. How is your fishing activity organised over the year?

	Number of months / year	Crew size	Number of trips per month	Number of customers per trip	Average duration of a trip at sea
Low season					
High season					

22. Nature of the trips
- ☐ Day trips
- ☐ Night trips
- ☐ Both

23. Apart from fishing, do you offer any other activities or products to your customers?
- ☐ Yes
- ☐ No

23a. If yes, please indicate their nature:
- ☐ Sightseeing trips at sea (without fishing)
- ☐ Observation of marine mammals
- ☐ Fishing equipment rental
- ☐ Boat rental
- ☐ Other (please specify) _____

24. Is fishing your only professional business?
- ☐ Yes
- ☐ No

24a. If no, please specify:
- the nature of your other business(es) : _____
- the share of your working time devoted to it (them) : _____% of your total working time

25. Are you a former professional fisherman?
- ☐ Yes
- ☐ No

26. Who are your customers?

	as a % of the total number of customers
Residents (local)	
National tourists	
Foreign tourists (specify main country of origin :)	

27. What weight of fish do you and your customers catch per year? _____kg

28. What % of the total catch comes from the MPA? _____%

29. What do you do with the fish?
- ☐ Shared among customers (customers keep their own fish for free)
- ☐ Sold for your profit
- ☐ Donated
- ☐ Other, please specify _____

30. What are the main species caught?

Name	Quantity (kg/year)	% of catch coming from the MPA	Ex-vessel price (€/kg)

COSTS

31. Annual fixed costs

	Euros / year
31a. Boat (maintenance and repairs, including engine)	
31b. Fishing gear (maintenance and replacement)	
31c. Other fixed costs (harbour dues, licence, buildings, insurance, management costs, advertising, etc..)	
Total	

32. Annual consumption of fuel and lubricant

	Quantity (litres/year)	Cost (€/year)
Fuel		
Lubricant		

33. Variable costs (i.e. costs that are approximately proportional to the number of trips)

	Euros / year	Euros / trip
33a. Total labour cost		
33b. Ice, bait and food		
33c. Fishing consumables (hooks, lines…)		
33d. Fuel and lubricant		
33e. Selling costs (auction taxes, etc.)		
33f. Other variable costs (please specify:)		

34. How many customers do you need for a trip to break-even? _____customers / trip

FISHING ZONES

35. How many fishing sites do you visit regularly?

Inside MPA	Outside MPA

36. Average duration of the journey from harbour to the main fishing sites?

	Duration	Distance
Fishing sites inside the MPA	_____ minutes	_____ nautical miles
Fishing sites outside the MPA	_____ minutes	_____ nautical miles

37. What are the 5 major factors influencing your choice of fishing site? Please rank these features from the most important (1) to the least important (5).

	Please rank
Abundance of fish	
Weather conditions	
Presence of particular species	
Regulations	
Your experience	
Safety (e.g. shelter from wind)	
Accessibility / proximity of the fishing area	
To go fishing where other fishermen already fish	
Proximity of a marine protected area	
Few fishers go fishing in this area	
Few other activities on this area (diving, surfing, sailing…)	
Other (please specify:)	

38. How are relations with others users?

	Good cooperation	Conflict	No contact
Other fishing charter operators			
Professional fishermen			
Independent recreational fishermen			
Spear fishers			
Divers			
Jet ski users			
Surfers, windsurfers, kite-surfers…			
Other users (*please specify* :)			

YOUR PERCEPTION OF MPAS:

39. For how many years have you been fishing in the MPA? _____

40. On the whole, what is the impact of the MPA on your fishing activity?
☐Very positive ☐Rather positive ☐No impact ☐Rather negative ☐Very negative

41. What do you think of the following statements?

	Fully agree	Rather agree	Rather disagree	Fully disagree	Don't know
Tourists come here mainly because of the MPA					
Tourists come here mainly for fishing					
Fishing inside the MPA matters to your customers					

42. What do you think of the following statements?

	Fully agree	Rather agree	Rather disagree	Fully disagree	Don't know
The MPA helps to protect biodiversity					
The MPA helps to enhance fish abundance inside the area					
The MPA helps to enhance fish abundance outside the area					
The MPA helps to attract tourists					
The MPA benefits mainly professional fishing					
The MPA benefits mainly recreational fishing					
The MPA benefits mainly scuba-diving					
The zoning system of the MPA helps to reduce conflicts among different types of user					
The MPA helps to reduce illegal fishing					
The MPA is good for the local economy					

43. Do you inform your customers of the existence of the MPA?
- ☐ Yes
- ☐ No

44. Do you inform your customers about specific regulations concerning ecosystem conservation and minimum landing size of fish inside MPAs?
- ☐ Yes
- ☐ No

45. Do you discard catches under the minimum size?
- ☐ Yes
- ☐ No

46. Would you agree to distribute a questionnaire about recreational fishing and MPAs to your customers?
- ☐ Yes
- ☐ No

47. Do you have any comments about our questionnaire and survey?

Thank you for your kind cooperation.

Evaluation of the catch of the day and the related professional fishing effort through landing surveys

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the monitoring to fishers and their local and regional representatives;
- Acceptance from professionals
- Plan an annual report on the results
- Discard métiers practiced outside the study area (e. g. MPAs and areas of influence).
- Link with other similar monitoring (e.g. national)

REMARKS

A preliminary study to characterize the parent population of professional fishers is recommended to ensure that the samples are well represented.

Landing surveys make it possible to collect information on fishing effort and catches for the day, or even to reconstitute the activity calendars over a longer period of time.

ACTIVITIES CONCERNED

Small coastal métiers in the study area and their gear: nets, longlines, traps including stationary traps, collection (sea urchins, shellfish).

Small off-shore métiers: swordfish, tuna.

Seiners (lamparos)

Objectives and expected results

Objectives

- Assess the overall fishing effort and the fishing effort deployed in the MPA
- Assess the catches made by professional fishers by métier, by gear, by trip
- Link these catches 1/ to the MPA / non-MPA; 2/ to an area or distance from the MPA or different fisheries regulatory regimes in the MPA
- Assess the impact on the resource by evaluating the samples. The FAO approach by métier (gear and target species) or by group of métiers of the same selectivity and targeting the same target species (e. g.'sea bream' nets), is preferred over the gear approach (Leleu *et al.*, 2014)
- Know the métiers practiced, the fishing gear used, the species targeted / sought after and caught according to the type of gear and the season
- Know the spatial (maps) and temporal (days, seasons, years) distribution on the study site (MPA and surroundings): 1/ gear; 2/ catches (CPUE) by métier, by gear category
- Be able to superimpose this distribution with a habitat mapping (locate possible vulnerable areas)
- Better manage uses as part of a management plan, reduce conflicts
- Demonstrate the effectiveness of the management measures put in place (i.e. the reserve effect of an area closed to fishing)

Expected results

- Observe the evolution of the fleet
- Quantitative assessments of professional fishing effort: number of vessels, fishers, gear
- Number of trips and number of gear per fisher, by MPA area or in the vicinity of the MPA
- Evaluation of the métiers, practices
- Identification of targeted / sought after species
- Qualitative and quantitative assessments (species, number, biomass) of catch per trip and catch per unit effort (CPUE)
- Quantified and spatialised elements to implement management measures

SAMPLING: TIME UNITS

Monitoring periodicity

The protocol can be reproduced annually.

Frequency

3 trips per month and per port (every 10 days) is a very good rhythm; once or twice a month already good.

Duration

Depending on the fishing effort and catches to be sampled for each vessel. If time is available and the arrival of the vessels is not simultaneous, sample several vessels.

SAMPLING: SPATIAL UNITS

Appropriate surface unit :

MPA or share of catch in or near the MPA in relation to the total catch in the fishing area (larger than the MPA)

Monitoring subunits :

- Areas by management category: full protection, partial protection, regulation of certain fishing activities, special site

FEEDBACK FROM EXPERIENCE

- Cabo de Palos Marine Reserve (ES)
- Gulf of Lion Marine Natural Park (FR)
- Torre Guaceto Marine Reserve (IT)
- Strunjan Marine Reserve (SI)
- Telascica Marine Reserve (HR)

Protocol description

- An investigator goes to the landing of the fish and collects information from the fisher (observation of the landing and questions to the fisher) concerning: gear, techniques, setting time and fishing grounds, target and heritage species (sizes, biomass). The fisher is asked about his daily catch.
- The number of boxes per species or commercial category is counted / requested from the fisher and the estimated average individual size (small / medium / large) or measured (measurement of one fish or a few fish representative of the box size) if they are calibrated. If time allows: the size of a few individuals in the main size classes is measured and an estimate is made of the number of fish per size class (number of fish per kg for small individuals) or a photograph of a crate is taken with a template.
- In order to avoid the manipulation of catches and according to the fishers' willingness to cooperate, the fisher can place the fish in crates so that they are clearly visible (a single layer for large fish). Doing so, the investigator can take a picture of each case by depositing a ruler as a scale for evaluating sizes (sizes defined in retrospecti) - FishMPABlue2 method.
- The trip form includes an observation section in which the investigator can record information given by the fisher relating to the fishing day, environmental conditions, by-catch, rare or flagship species encountered, for example.
- The investigation should last as short a time as possible because the fish must be sold directly or to the fish wholesaler or put in a cool place to be transported and auctioned. Measurements must be taken as quickly and accurately as possible, avoiding unnecessary handling of the fish. The objective is to understand the total catch, then to assess the total catch of the main target species. In order to measure individuals representative of size, it is better to collect data on catch by weight and number (assessment of the total catch) than to measure each fish accurately.
- Information to be collected by the landing survey: monitoring of the day's activity and information on the previous week, 10 days or month, depending on the periodicity of the monitoring.
  - Information on fishing location:
    - location of gear on a map (name of fishing site, zoning) and setting depth (minimum, maximum), conditions (current, swell)
  - Fishing effort:
    - type of métier, gear (net, longline, trap) and characteristics (length, mesh size of nets, hook size), number, setting times
  - Captures:
    - for each gear: name of species(s) caught, number, height / weight (or provide small / medium / big grids), if no catch, indicate this
  - Observations:
    - other users encountered, invasive species, pollution
    - free comments
- Handing over the forms to the MPA can be done in different ways:
  - automatically on a database of the investigating body if the logbook is online
  - following regular visits to the port (periodicty to be defined) by the investigator in order to collect data from the past period. This type of data collection makes it possible to maintain regular exchanges with fishers, a relationship of trust and collaboration can be established
  - delivery to the investigating body (mail, hand-delivery) on a periodicity to be defined (semi-annual, annual). A new fishing logbook is then issued in exchange.
- Feedback from data analysis should be encouraged to maintain the support of fishers and their participation in data collection. This can be done by automatic analyses (type of fishing carried out per trip, on the site, etc.) in the case of an online logbook or during an annual feedback meeting to be organised by the MPA (with the investigating body if necessary). This protocol may be supplemented by site use counts, catch declarations, boardings.

Implementation advice

- As with all sampling plans, the question of panel representativeness is paramount. It is therefore important to have information on the métiers practiced by fishers, to choose the métiers that you want to monitor (importance of the number of practitioners, target species of importance for conservation or management, etc.) and to carry out sampling with many replicates per métier (high spatial and temporal variability in catches).
- A preliminary survey (maritime authorities, Ministry of Fisheries or representatives of local fishers) is recommended to define the representative parent population of fishers (see corresponding sheet). The results obtained will thus be compared with the parent population. In the case of an obligation to report catches on landing (specific regulation or charter), the parent population is the sampled population.
- The know-how can vary significantly from one fisher to another. In the case of a voluntary approach, care should be taken to ensure that certain types of fishers are not under-represented (e.g. novice, retired, specialised in one type of fishing, occasional fisher on site or using several landing points).
- Also sample outside the managed areas to be able to evaluate fisheries management measures.
- Anonymity must be guaranteed to fishers, for this reason the data are aggregated and returned in a global way.
- The fisher is directly questioned by the investigator about the catch of the day and the catch of previous days, he indicates the gear (length for nets, number of hooks for longlines, number of traps) and places them approximately on a map
- Depending on the quantity landed, fisher's habits and air temperature, the number of fish boxes is counted by category or species and a few representative individuals are measured and weighed (if possible). Questions may be asked about by-catch (qualitative). It is important to note as much information as possible. Sheets should be prepared to facilitate data collection.
- To save time, photos can be taken of each box landed, not forgetting to affix a centimetre scale in the box. The size and number of catches can thus be determined in retrospect from the photos.
- It is advisable to attach a map to the questionnaire used by the interviewer so that the professional can report or have reported the location of the sampled gear on the day of landing (GPS coordinates if possible).
- Train investigators in species recognition.

Difficulties, advantages / Disadvantages

- This method requires the collaboration of fishers who answer questions about their fishing day and the site of origin of the catches.

Advantages

- Data collection can be done internally, by paid interviewers or by scientific monitoring partners
- Surveys make it possible to raise awareness and train MPA officers in fishing, to get to know fishers better, to exchange various information with them on the species life cycle, the environment, pressures on the territory, etc.
- Possibility of sampling several vessels in the same port or several ports in the same half-day
- Allows effort and catch data to be obtained simultaneously by profession without going to sea (shorter sampling time than for boarding)

Disadvantages

- Inaccuracy of the location of the gear (however, the drawing or zoning is often sufficient for the monitoring of the MPA)
- Very limited exchange time with fishers due to the sale that must be made with customers or the fisher waiting for the fish, and the heat (summer); refusal likely depending on the day
- The larger the vessel and the larger the catch, the more experienced the observer should be; do not hesitate to come with 2 observers at the beginning
- Risk of omission of fishing gear without catch (zeros are important) and errors or inaccuracies in last week's activity and catch
- Difficulty to survey fishers with a very specific and more occasional activity (lower number of trips)

Material

- Standard survey form with map to position the fishing gear of the day
- Fish ruler, tape measure, waterproof scale, weighing machine
- Camera and template or bracket for photos, possibly dictaphone
- Appropriate clothing: boots and possibly overalls and gloves for handling fish or fish crates

€ Estimated costs (€: low, €€: medium, €€€: high)

€€€ Human resources (help from internship students and / or volunteers can reduce costs)

€/€€ Specific service for the collection of data at landing: specialized or scientific design office = € or €€ otherwise time taken by the management team if qualified

€€ Plan external service for the design of a database if necessary

€ Material

€€ Data analysis, desirable partnership with scientists

Administrative procedures, legal provisions

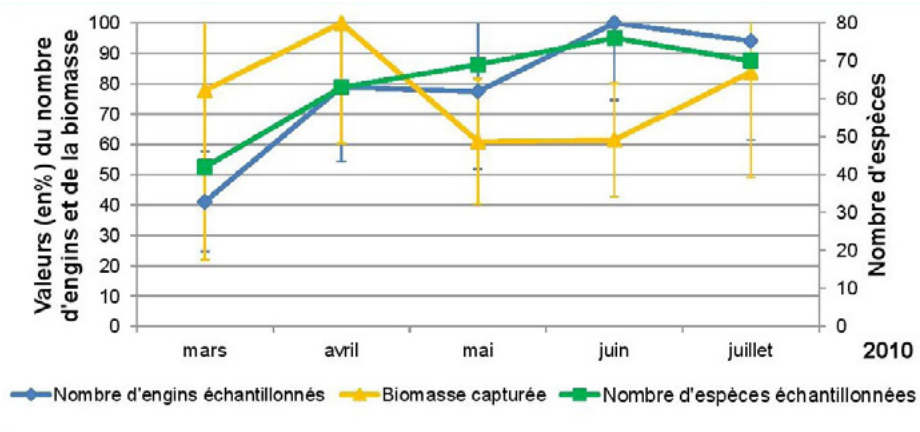
- Notify the authorities in charge of collecting fisheries data (government departments or institutes)
- Authorisation to access certain landing areas or inside certain ports
- Respect for statistical confidentiality: aggregation of catches from at least 3 vessels per category; guarantee of anonymity

Type of results obtained / Metrics

- Basic metrics:
  - total biomass captured during the trip
  - biomass of the main target species caught during the trip
  - number of machines worked during the trip and the previous week
- Derived metrics:
  - average number of trips / month, per season or per year
  - Average CPUE / sector / season or by year
  - CPUE for all métiers combined for the target species of the fishery by area
  - CPUE by métier or group of métiers targeting a commercial category grouping several species ('soup','bouillabaisse','sparidae') or a target species (*Mullus surmuletus*) by area
  - CPUE all species total and average, target species / sector / day
  - Frequency of occurrence (%) in catches of MPA heritage species (*Epinephelus spp.*, *Scyllarides latus*, Elasmobranchs)

Graphical representations

- Tables, histogrammes of site use as a function of temporal (day, season, year) and spatial (sector / area) variables, of the various métiers, gear used, catches, CPUE, discards.



Proportions of number of gear sampled (in blue), biomass caught (in yellow) and number of species sampled (in green) between March and July 2018 (Lenfant *et al.*, 2011)

To go further

- Leleu *et al.*, 2014. Métiers, effort and catches of a Mediterranean small-scale coastal fishery: The case of the Côte Bleue Marine Park. Fisheries Research, 154, 93-101.
- Lenfant *et al.*, 2011. Les débarquements de la pêche artisanale: de Leucate à Port-Vendres (2008-2010). Rapport CEFREM pour Agence des Aires Marines Protégées (1/3), 48 p.
- Neveu R., Caro A., Lenfant P., Gudefin A., Missa A., Jarraya M., (2012). Les débarquements de la pêche artisanale : Parc Naturel Marin Golfe du Lion (2007-2012). Rapport CEFREM pour Agence des Aires Marines Protégées, fiches descriptives, 62 p.
- Caro A., Neveu R., Gudefin A., Missa A., Lenfant P., 2012. Suivi et évaluation des débarquements de la pêche artisanale au sein du Parc naturel marin du golfe du Lion (rapport 2012). Rapport CEFREM pour Agence des Aires, Marines Protégées, 93 p.
- https://Fishmpablue-2.interreg-med.eu/

Monthly or yearly assessment of catches and associated fishing effort: reconstitution of an activity schedule by landing survey

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Observations of fishing trips by landings must generally be made with the authorisation of local fishing managers (prud'hommes, Maritime Affairs) and fishing bosses.
- Discard professions practiced outside the study area (e. g. MPAs and areas of influence).

REMARKS

The landing survey makes it possible to simultaneously collect information on fishing effort and catches for the day, but also to reconstruct the activity calendar of the previous period (week, decade, month).

Applicable to small ports and / or small number of active vessels

ACTIVITIES CONCERNED

Small coastal métiers in the study area and their gear: nets, longlines, traps including stationary traps, gathering (sea urchins, shellfish).

Small offshore métiers: swordfish, tuna.

Seiners (lamparos)

Objectives and expected results

Objectives

- Identify active vessels through documentary research, the métiers they practice and the gear they use; use statistics and fisheries services, or even data held by fisheries organisations, for this purpose
- Contact the fishing managers and ask them if they agree to participate in the monitoring; do not neglect this time to explain the project, objectives and terms and conditions and discuss the manager's expectations regarding the monitoring
- Construct a schedule of observations of landing fishing trips in an acceptable periodicity between the precision required for the monitoring, the constraints related to human and financial resources, and the constraints of fishing managers: 1 to 3 times per month

Expected results

- Evaluate the effort and catch of the different métiers practiced in the study area during 1 month
- Extrapolate to the year for the métiers monitored and if all months have been sampled.
- Observe the evolution of the fleet, obtain a trend by métier, monitor the evolution of the quantity and diversity of catches
- These field surveys aim to identify the fishing effort of the day and month, while integrating certain more qualitative aspects of the activity and observations of professional fishers, including feedback on certain heritage species, such as the great cicada, the corb and the grouper

Details of the data acquired by this type of monitoring and the expected results will be found in the sheet 'Evaluation of the day's catches in relation to a professional fishing effort by landing survey', which should be consulted first. This sheet is complementary.

SAMPLING: TIME UNITS

Monitoring periodicity

To be reproduced at regular time intervals every 3 to 5 years, for example. Reduce this time step if an acceleration of the fishing pressure is observed

Frequency

10 days on average (between 8 and 12 days), i.e. 3 trips per month and per port, with regular systematic sampling of the different days of the week; adaptable 1 trip / month

Duration

1 year minimum.

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA or share of catches in the MPA in relation to total catch of fishing area

Monitoring subunits

- Areas by management category: full protection, partial protection, regulation of certain fishing activities, special site

FEEDBACK FROM EXPERIENCE

- Côte Bleue Marrine Park (FR)

Protocol description

This method makes it possible to observe fishing trips when vessels land, i.e. when they arrive in port.

- An investigator goes to the landing of the fish and collects information from the fisher (observation of the landing and questions to the fisher) concerning: gear, techniques, setting time and fishing grounds, target and heritage species (sizes, biomass). The fisher is asked about his daily fishing but also about his activities and catches in the previous period (week, decade, month), which makes it possible to extend the evaluation of catches over the interval between 2 sampling sessions.
- The frequency of the surveys must make it possible to reconstitute the monthly activity calendar of the vessel: its number of days of trips and the resulting catches by métier.
- Catches are recorded for a sample of reconstructed fishing operations and selected to be representative of the métiers practiced during the period (Leleu, 2012).

Effort data

- At each field trip in a port, all active and inactive vessels are surveyed (step 2; figure below; Leleu, 2012). For each active and voluntary vessel, fishing trips are sampled (step 3; figure below; Leleu, 2012). An exhaustive record of all fishing operations carried out during the fishing trip on the sampled day is then made (step 4; figure below; Leleu, 2012). The fishing trips and operations of the previous 6 days are recorded for each vessel. Days when the vessel did not go out are considered inactive.
- For each fishing operation, several pieces of information are recorded:
  - Main target species or group of species and by-products
  - Fishing gear (gillnet, trammel net, combined net)
  - Length
  - Height
  - Mesh size
  - Date and times of setting / lifting or duration of setting
  - Minimum and maximum setting depths
  - Fishing area (drawing, GPS points, oral information)
- For the location of the fishing operation and when possible, 1/ the drawing of the setting can be requested from the fisher, with a map of the area separated from the notes and anonymous (put code or survey number) as support. When fishing grounds are outside the area, a geographical reference (locality, beacon, etc.), distance to the coast, distance to the nearest MPA boundary and distance to the port of operation are requested. 2/ zoning can also be used to locate gear and catches.
- Each setting drawing is manually transferred to a well-documented geographic information system software (ArcGIS®, QGIS). Around each setting drawing, a 50 m radius buffer zone is then delimited to take into account the spatial uncertainty associated with the drawing, thus creating a polygon. Each polygon is then considered to be the fishing area, where the length of the set nets is evenly distributed. Each fishing site is characterised by its minimum, average and maximum distances to the coast, the nearest MPA and the port of exploitation using the GIS or a GeoWizard® type application.

Catch data

- To sample each fishing operation, the total catch is identified and weighed or the total catch by sales category is identified and weighed. The weight and size of a sub-sample of these catch categories shall be measured. Sub-sampling of catches shall be carried out in order to obtain the average size and weight of individuals by species using a scale and ruler adapted to the desired precision. Photographic methods may be used to assess the size and number of catches, if not size categories (small / medium / large).

Implementation advice

- For details on the landed sampling methodology and the data to be acquired, consult the sheet "Evaluation of the day's catches". This sheet is devoted to describing the protocol of investigators coming, for example, 3 times a month to reconstruct an activity schedule and the catches of the fishers surveyed.
- Sample the main ports or landing points concerned by landings of catches from the study area and all ports, if possible.
- For each sample, the number of species of the total landed catch is recorded (from family to species, or by species category) and the total catch is weighed. Where possible, individuals are counted by species. A photo may be taken of the number of boxes or each box when there is not enough time to count each fish at time of landing.
- For some catches that cannot be weighed, visual estimates are made. Sometimes boxes, for which only the weight is known, contain a mixture of species. A photo is then taken to determine the number of individuals by species contained in the box.
- The total weight by species can be obtained by visually evaluating or photographing if the fish are not arranged in several layers, the proportion of the species in the box.

Difficulties, advantages / Disadvantages

Advantages

- Makes it possible to simultaneously obtain effort and catch data by métier for the day and the period that has just elapsed without going to sea (shorter sampling time than for boardings)
- The questions concerning the previous week's activity and catches allow the activity calendar, effort and catches to be reconstructed over a period ranging from one week to 10 days
- This protocol makes it possible to extrapolate the total catch per year by métier if sampling is carried out correctly
- Possibility of sampling several vessels in the same port or several ports in the same half-day

Disadvantages

- It is imperative to have good landings surveyors (rigour, knowledge of species, alertness and sharpness so as not to omit certain information and quickly carry out individual height and weight assessments or a sub-sampling of catch boxes). However, it is possible to train motivated investigators fairly quickly
- The method is based on the accuracy of the information provided by the fishing manager about the catches of the days prior to sampling. This method is not to be used until a relationship of trust is established (except for the same difficulties as with declarative methods)
- Risk of omission of fishing gear without catch (zeros are significant) and errors or inaccuracies in last week's activity and catch.
- Does not allow the assessment of bycatch, discards and their causes, but only the catches retained and landed

Material

- Fish ruler, tape measurer, waterproof scales, weighing machine
- Camera and photo template
- Activity reconstitution form (moisture resistant paper, slate or tablet)

€ Estimated costs (€: low, €€: medium, €€€: high)

€€€ Human resources (help from internship students and / or volunteers can reduce costs)

€€ Specific service for data collection,specialised design office €€€, otherwise time taken by the management team if qualified

€ Investment / material

€€ Data analysis

Administrative procedures, legal provisions

- Notify the authorities in charge of collecting fisheries data (government departments or institutes)
- Authorisation to access certain landing areas or inside certain ports
- Analysis and restitution of data subject to statistical confidentiality: aggregation of catches of at least 3 vessels per category, guarantee of anonymity

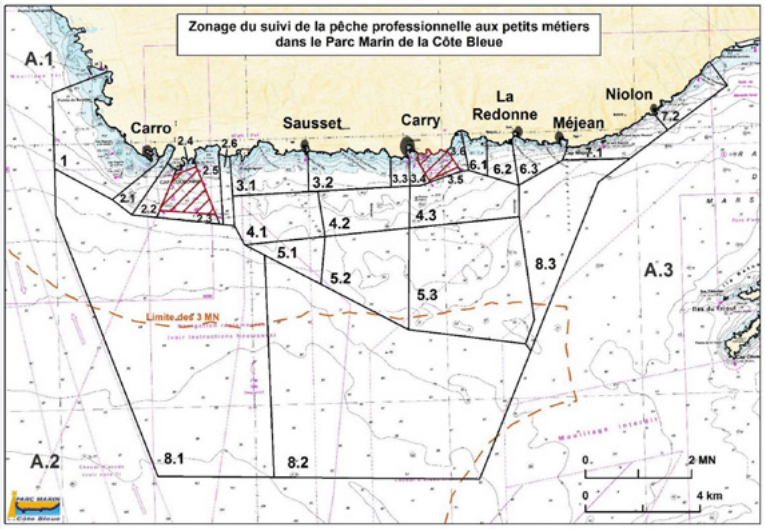
Type of results obtained / Metrics

- Basic metrics by business line:
  - number of trips from the last decade
  - number of gear worked per trip
  - total catch per trip (kg)
  - catch of the main species fished (kg)
- Derived metrics :
  - number of trips / boat / year or season or month
  - average number of fishing operations / trips
  - total or average catch / trip landed (retained)
  - catch per unit of effort retained / sold
  - number of métiers practiced all year round by period

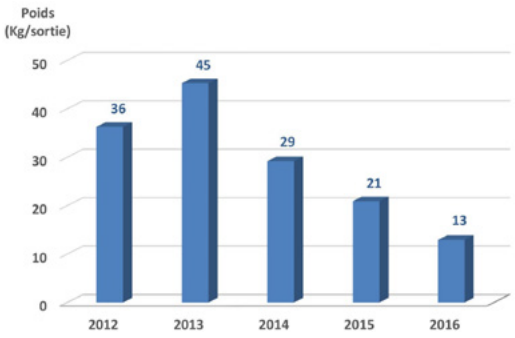
Graphical representations

- Tables, histogrammes of the different activities and fishing effort (vessels, gear) according to temporal (day, season, year) and spatial (sector / area) variables
- Tables, histogrammes, gear used, catches, CPUE, discards, composition of landings

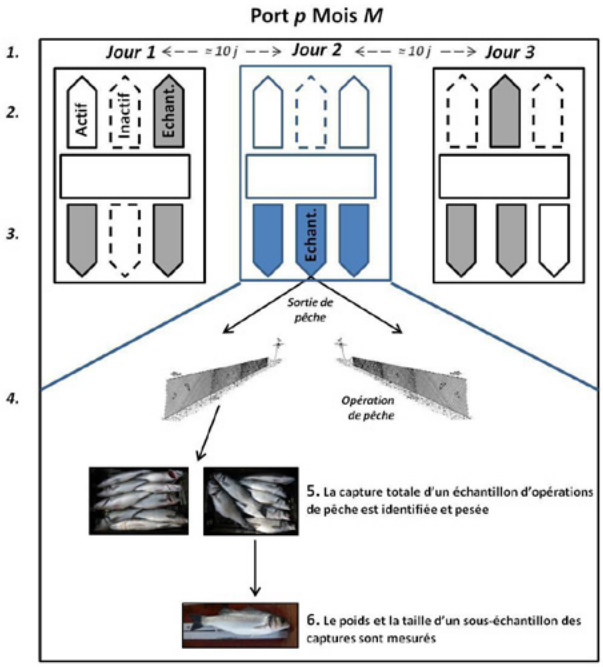
Zoning used for monitoring professional fishing in the Blue Coast Marine Park (Charbonnel *et al.*, 2017)



Evolution of average catch volumes per fishing trip and per vessel between 2012 and 2016 (according to Cadville *et al.*, 2017 in Charbonnel *et al.*, 2017)



Scheme of data collection carried out during observations of fishing trips for landings. At each trip from the field on a port, the number of active (full line) and inactive (dotted line) boats is recorded. Fishing trips of active and voluntary vessels are sampled (full vessels). For each sampled fishing trip, all fishing operations are recorded and reported. All fishing trips and operations carried out during the 6 days preceeding the field trip shall also be recorded. (Leleu, 2012)



Assessment of catches and associated professional fishing effort through surveys on board vessels

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the monitoring to fishers and their local and regional representatives
- Acceptance of professionals
- Vessel adapted for the boarding of an observer

REMARKS

A preliminary characterization study of the parent population of professional fishers is recommended to ensure that the vessels/fishers surveyed are well represented.

Only boardings allow to evaluate the total catch, CPUE and discards by gear, species or commercial categories.

This protocol is applicable to scientific fisheries, in which case the fishing gear, sites and duration are fixed in advance as part of a sampling strategy meeting a management objective and are no longer left to the discretion of the fisher.

ACTIVITIES CONCERNED

Small coastal métiers and their gear: nets, longlines, traps including stationary traps, gathering (sea urchins, shellfish

Objectives and expected results

Objectives

- Assess the catches made by professional fishers by métier, by gear, seasonally or annually
- Link these catches 1/ to the MPA / non-MPA; 2/ to an area or distance from the MPA or different fisheries regulatory regimes in the MPA
- Assess the impact on the resource by having accurate access to samples (target species and bycatch) and discards
- More accurately assess the fishing effort by having access to gear characteristics and practices (including setting time)
- Better understand who works in the study area
- Better understand the strategies developed by fishers and their distribution in the fishing area. Better delimit this territory in relation to the MPA and the home port of the vessels working in the area
- Know the métiers practiced, the categories of fishing gear used, the species targeted / sought after and caught according to the type of gear and the season
- Know the spatial (maps) and temporal distribution of these sampling activities in and around the MPA (day, season, year)
- Know the spatial (maps) and temporal distribution of catches made (CPUE) by profession, by gear category, taken from the MPA and around (day, season, year)
- Be able to superimpose this distribution on a habitat map and, if necessary, locate vulnerable areas
- Better manage uses as part of a management plan, reduce conflicts
- Demonstrate the effectiveness of areas closed to all fishing practices or subject to regulations
- Supplement the data acquired with other protocols (site use or effort counts, fishing logbook, perception surveys, etc.)

Expected results

- Precise quantitative assessments of catches (species, number, biomass)
- Catch-per-unit-effort assessment (CPUE) and bycatch of vulnerable species
- Number of gear worked per fisher, by MPA area or in the vicinity of the MPA, per day
- Details concerning the setting times of the gear used in each season
- Knowledge of métiers, practices
- Identification of target / sought after species, bycatch, the proportion of discards / bycatch to catches, by species (by métier) and their causes quantified and spatialised elements to implement appropriate management measures with professional fishers

SAMPLING: TIME UNITS

Monitoring periodicity

The protocol can be reproduced monthly, seasonally or annually

Frequency

Several trips per month, per season, per type of métier is a tight sampling. Seasonal series of boardings make it possible to characterise the activity and calculate average CPUE per gear type or per métier (between 20 and 30 for example, to sample between 60 and 100 gear)

Duration

Variable according to fishing effort and abundance of catch, half-day or full-day trip

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA or share of gear located in or near the MPA in relation to the total catch of the day

Monitoring subunits

- Areas by management category: full protection, partial protection, regulation of certain fishing activities, special site

FEEDBACK FROM EXPERIENCE

- Port-Cros National Park (FR)
- Scandola Nature Reserve (FR)

Protocol description

- Depending on practices, the FAO approach by métier (target gear and species) or by group of métiers, with the same selectivity and targeting the same target species (e.g.'gilthead' nets (gillnet, trammel net and combined nets) or the gear approach (Leleu *et al.*, 2014) will be preferred at the time of the sampling plan and when analysing the data.
- The MPA provides an agent or scientist who boards with a professional fisher and follows his activities during the day's trip. Unlike scientific fisheries, the fisher acts as usual, the observer does not give any instructions. The fishing location is noted (recommended zoning, identical to the zoning used for gear or boat counts) and the time of each fishing operation (lifting or setting). The characteristics of the gear set and surveyed shall be recorded (type, length, mesh for nets, number of hooks for longlines, number of traps, and their setting time). The catch removed from the net by the fisher is measured and weighed.
- During the trip, which can last a few hours or a day / night in most cases, dialogue is established with the fisher concerning practices, fishing areas, changes in catch and all kinds of interesting observations concerning species and the environment, the impact of uses, potential conflicts with other users. Many explanations can be given about the fishing activities and the context in the MPA. It is strongly recommended to take notes in order to keep this information and make it accessible to other monitoring or MPA partners.
- The notes are taken on a waterproof support (diving slate or underwater paper), for each operation: setting or lifting.
- Information to be collected during the on-board survey:
  - Date
  - Fishing location: zone name or GPS point
  - Operation: setting or lifting
  - Operation time (and set time if lifting a gear)
  - Gear parameters: type (net, longline, trap, etc.) and characteristics (mesh, length, height, number of pieces, hook size), setting time and depth
  - Catch: species name (Latin recommended), height, weight, sex and reproductive status (particular appearance, presence of eggs), if visible; if no catch, indicate it (zeros are important)
  - If rejected, indicate the reason: size below the catch limit, species not traded, catch damaged by the winch or eaten by fleas or attacked by a predator (conger, moray eel, dolphin)
  - Observations: other users encountered, invasive species, pollution, any comments regarding habitats and species, users, MPA and management. These summarised remarks can be very useful for interpreting monitoring data or for management purposes
- Photographs are taken during boarding and are used to identify species in case of doubt (do not hesitate to take several photos (dorsal and ventral views for example). They are also useful for illustrating reports and presentation of results and for creating a documentary collection on fisheries in the MPA.
- Measures must be taken quickly to minimise fish handling. It is recommended to use gloves to reduce the risk of fish escaping. The observer can directly store the fish according to the fisher's instructions in a cooler, a jute bag, out of direct sunlight etc. Sub-sampling is avoided as long as there is sufficient time to process the catch between the lifting of 2 gear. This is more difficult if several fishers clean up the nets.
- The measurement of fish is the standard length (Lst) and the total length (Lt) to the nearest 0.5 cm (see glossary), that of crustaceans is the length of the cephalothorax; for molluscs weighing is preferred.
- Biomass is measured using a water-resistant electronic scale.
- At the end of the boarding, data are copied onto a mission logbook, which includes all the data from the campaign. It is strongly recommended to 'clean' the data collected as

soon as possible. This important step is the validation of the data. Some omissions can be rectified. The species must be checked one last time using photos taken on board in case of doubt and the results compared, if necessary, with other observers on board other vessels on the same day or at the same time.

- The validated data can be entered later or at the time of data analysis into a database, at least on an Excel® spreadsheet.
- A feedback of the results of the monitoring should be planned each year, organised by the MPA with all survey participants, to share information, maintain fishers' support, involve them in the monitoring and take joint management measures. If possible, work with fishers on the restitution format to integrate results of interest to them.

Implementation advice

- As with all sampling plans, the question of panel representativeness is paramount. It is therefore important, in advance, to have information on the métiers practiced by fishers, to choose the ones you want to follow (importance of the number of practitioners, target species of importance for conservation or management, etc.) and to carry out a stratified sampling with many replicates per métier (because of the high spatial and temporal variability of the catch).
- A preliminary survey (maritime authorities, Ministry of Fisheries or representatives of local fishers) is recommended to define the representative parent population of fishers (see corresponding sheet). However, it is not advisable to extrapolate to the whole year and to the fishing fleet from the few dozen boardings made per season without the assistance of a specialised scientist.
- The know-how can vary significantly from one fisher to another depending on his experience. In the case of a voluntary approach, care should be taken to ensure that certain types of fishers are not under-represented (e.g. novice, retired, specialised in one type of fishing, occasional fisher on site or using several landing points).
- It is important to sample outside the managed areas in order to assess the effectiveness of management applied in the MPA or in some areas of the MPA.
- The on-board observer shall not be entitled to participate in fishing operations. He must ensure that he does not obstruct the manoeuvre or delay operations when the ship arrives in port.
- Observers may be members of the management team, scientists, subcontractors, students and trained interns.
- The length of the net or the number of longline hooks or the number of traps and the setting time are essential characteristics to be able to reduce catches to a standard unit.
- The location of the fishing gear is a delicate point since the observer then has access to the professional fisher's fishing areas and therefore to his strategy and part of his know-how. For this reason, it may be decided not to record the precise GPS point of the set or lifted gear but simply to locate it in the monitoring zoning. This precision can be considered sufficient if the zoning is well done. If fishers agree (validation meeting before the start of the monitoring), the geographical coordinates can be recorded using a portable GPS.
- Anonymity must be guaranteed to fishers when the data are restituted, which means that the data are aggregated and shared in a global way.
- Accurate results on catch and discards by species, including CPUE, provide an important basis for management measures and discussions with fishers.
- It is advisable to board with a nautical map or a zoning map when the area is not fully known.
- The archiving of data and photos taken on board must be done per day, per ship, per campaign for the documentary collection to be usable.

Difficulties, advantages / Disadvantages

This method requires a strong commitment from fishers in monitoring, who agree to take observers aboard their vessel for several hours of fishing, to trust and share their knowledge.

Advantages

- Accuracy of catch data and access to bycatch and discards
- Data collection can be done internally, shared or delegated to scientists or partner consultancies
- This type of monitoring makes it possible to maintain regular exchanges with fishers, creates the opportunity for a long exchange time on board the fishing vessel and is very instructive for agents who are not familiar with fishing
- Data restitution is a good reason to hold an annual meeting on fisheries and to discuss management measures between managers, fishers and scientists

Disadvantages

- Sampling takes time and tires teams
- Time to recopy and validate the data should not be under-estimated
- Optimisation of this sampling when observers are known, experienced and appreciated by fishers; difficulties linked to relationships between people
- Problem of boarding authorisations for additional people, especially on small boats (safety equipment)
- Difficult acceptance by professional fishers to allow a person otherwise in charge of fisheries policing to be taken on board as an observer (obvious conflict of interest); in this case, delegate the observation to scientists, for example
- Bias related to weighing at sea (errors due to vessel movements). This error, which can reach several dozens of grams, is compensated by the number of individuals weighed, with regard to the application of height-weight relationships that are often poorly adapted to the area. A choice needs to be made.
- Do not underestimate the time or cost of using the data after the fact

Material

- Waterproof slate or underwater paper, pencil, possibly dictaphone
- Fish ruler, tape measurer for large individuals or fish that are difficult to handle
- Waterproof scale
- Camera and photo template, portable video camera type GoPro®
- Appropriate clothing: boots and possibly overalls and gloves for handling fish or fish crates (hand protection and less risk that fish escapes)

€ Estimated costs (€: low, €€: medium, €€€: high)

€€ Human resources: the sampling effort can be significant and therefore costly in time and manpower depending on the parent population and the number of métiers practiced

€ Specific service for data collection & **€€** if external service for database design (BDD)

€ Investment / material in the case of a paper format. Significant investment in the first year for the development of the database tool, followed by maintenance, but possible pooling at national level or between MPAs

€€ Data analysis

€ Feedback to fishers (**€€** if service provider)

Administrative procedures, legal provisions

- Declaration of observers' boarding to maritime authorities
- Respect for statistical confidentiality: aggregation of catches from at least 3 vessels per category

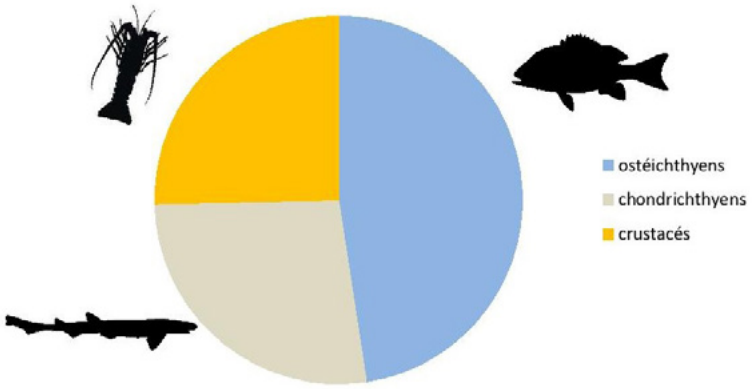
Type of results obtained / Metrics

- Basic metrics:
  - total biomass caught per trip
  - number of trips / month, by season or year
  - number of gear worked per trip
  - composition and biomass of by-catch
- Derived metrics:
  - average number of trips / month, per season or per year
  - average CPUE / sector / season or by year
  - CPUE for all métiers combined for the fishery's target species by area
  - CPUE by métier or group of métiers targeting a target species (*Mullus surmuletus*) or a commercial category grouping several species ('soup','bouillabaisse','sparidae') by area
  - total and average CPUE for all species, for target species / sector / day
  - frequency of occurrence (%) of catches of MPA heritage species (e.g. *Epinephelus spp.*, *Scyllarides latus*, Elasmobranchs)

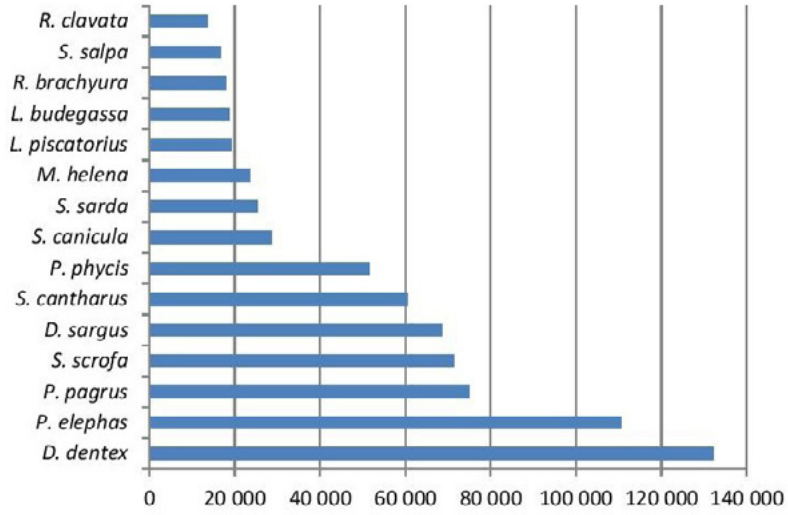
Graphical representations

- Composition of catches and by-catches by season, year, management area
- Average CPUE per gear, per area, per year

Composition of by-catch fisheries by group during boardings in spring 2013 in the Scandola nature reserve (Le Diréach *et al.*, 2015)



Dominant biomass species (g) in the May 2013 catches observed on board professional fishing vessels working around the Scandola nature reserve (Le Diréach *et al.*, 2015)



To go further

- Cadiou *et al.*, 2009. The management of artisanal fishing within the Marine Protected Area of the Port-Cros National Park (northwest Mediterranean Sea): a success story ? ICES Journal of Marine Science, 66: 41-49.
- Le Diréach *et al.*, 2004 Monitoring the artisanal fishing effort in marine protected areas on the French Mediterranean coast. Revue d'Écologie (Terre Vie), 59: 77-84.
- Le Diréach *et al.*, 2015. Suivi de l'effort de pêche professionnelle dans la réserve naturelle de Scandola (Corse). Données 2013. Contrat Parc naturel Régional de Corse & GIS Posidonie publ., Fr. : 54 p. + annexes.

Assessment of red coral and coralliferous areas fishing effort

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the approach and monitoring methods, acceptance of professionals
- Tool that can be implemented within the framework of a charter

REMARKS

The species *Corallium rubrum* is listed in Annex III of the Berne Convention and in Annex III of the Barcelona Convention

It is the subject of a recommendation (GFCM/36/2012/1) concerning its exploitation in the GFCM area of action

For EU countries, it is included in Annex V of the Flora and Fauna Habitats Directive

This particular fishery can be difficult to apprehend and evaluate. The cross-referencing of several protocols and information sources can provide coherent costed elements for management

ACTIVITIES CONCERNED

Red coral fishing

Objectives and expected results

Objectives

- Assess the use of the site by professional fishers
- Have information on the profile of professional coral fishers working in or around the MPA: port of registry, working technique used (air diving with air, mix, rebreather, scooter, ROV use), working depth range, individual coral fisher with or without a boat, operating equipment, both, or owner employing divers
- Collect information on practices and harvest to map the contours of this fishery in the MPA
- Identify the presence of illegal fishing in the MPA (use of the cross of Saint Andrew or the Italian bar, exploitation in prohibited areas)
- Know the spatial (fishing sites and / or deposits previously exploited) and temporal (days, seasons, years) distribution of sampling
- Be able to superimpose this distribution on a habitat mapping
- Define as soon as possible the state of the stock in the MPA area: potential area (habitat mapping), but also the total weight per fishing action, branch size (information that is difficult to access but can be collected through testimonies)
- Assess the impact of this fishery on benthic populations: current and past impacts (when the cross of St. Andrew or the Italian bar was used)
- Reconstruct the history of this fishery in the MPA (photos, testimonies - see fact sheets dedicated to the historical investigation - and interviews with old fishers)
- Understand the legal, economic and social context of coral fishing: legal (often traders from Torre del Greco in Italy directly to the fisher) and illegal sales channels, but also on-site processing, shops owned by coral fishers
- Assess the economic impact
- Understand the specific relationships that fishers have with red coral: knowledge of biological characteristics
- Identify the factors that determine the diversity of observed behaviours: the process of land appropriation, acceptance, adherence or rejection of certain management measures
- Manage the sustainability of this fishery as part of a management plan
- Assess the effect of regulating or prohibiting this fishery on part of the MPA territory (if applicable)

SAMPLING: TIME UNITS

See elements in the corresponding sheets or following the protocols presented in the section 'Protocol description'.

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around if no-take zone or if measured management effect or if nearby colonies

Monitoring subunits

Management areas: full protection and fisheries control areas (if applicable), favourable sites, colonies

FEEDBACK FROM EXPERIENCE

- Cap de Creus Reserve (ES)
- Natural Park of Montgrí, the Medes Islands and the Baix Ter (ES)
- Calanques National Park (FR)
- Scandola Nature Reserve (FR)
- Kabyles Bank Marine Reserve (DZ)

Expected results

- Quantitative assessments of fishing effort (number of boats, fishers, surface markers in working areas (seen in Corsica)
- Typology of professional fishers (origin, technology used, seasonality of practices, other fishing activities practised: fishing for sea urchins, sponges for example)
- Techniques used (manual collection) but also illegal (cross of Saint Andrew, Italian bar)
- Proportion of fishing carried out in and out of MPAs
- Elements of information making it possible to draw the outlines of a quantitative evaluation (weight, branch size) of the harvests carried out (information that is difficult to access but can be collected through testimonies)
- Quantified and spatialised elements to implement appropriate management measures;
- Quantified elements of the impact of this fishery on the local coral population
- Know how fishers perceive the state of the environment and the evolution of the resource
- Know how fishers see the effects / impacts of their own practices on the resource and the environment
- Know what views fishers have of the other actors in the MPA territory (other users, managers, decision-makers, associations, etc.): territories of practice, actual and / or potential conflicts, responsibilities, etc.
- Exchange with fishers on the biology of red coral and the dynamics of stock recovery
- Determine fishers' knowledge of regulations and the different management actions within the MPA: understanding, acceptance / rejection, effectiveness, legitimacy, suggestion

Protocol description

- The assessment of the **fishing effort** for coral *Corallium rubrum* can be made from:
  - visual counts of boats (site use) from a boat / at sea or from the shore / ashore (see corresponding sheets)
  - declarations by a fishing logbook filled in by the fishers themselves (see corresponding sheet), at least of the proportion of coral caught in the MPA: authorisation to exploit subject to the return of the information
  - interviews that can address the perception, socio-economic and / or historical aspects (see corresponding sheets)
- Consulting **local and national statistics** from the ministry in charge of this fishery, or from traders, jewellery workshops, can provide figures (beware of the veracity of the often deliberately erroneous figures) on harvests and the number of fishing licences (Tsounis *et al.*, 2007; Deidun *et al.*, 2010). These consultations may be carried out at least annually for information purposes (consultation of the annual reports). It is clear that these figures must be considered with caution. The difficulty lies in the evaluation at the local level, close to the MPA. However, having in mind some reference figures at national and regional level may be useful.
- The assessment of the impacts of fishing and the status of the stock can be done in sites accessible by scuba diving from explorations at a given time by observing visible harvesting marks. It is possible to have either a temporal approach (the same site monitored over time) or a spatial approach (followed in parallel by a site where fishing is practiced and a site where it is prohibited). The only regions of the Mediterranean where coral lives at modest depths, i.e. exploitable for scuba diving, is the Marseille region and French and Spanish Catalonia. The use of visible marks therefore concerns only a few sites in the Calanques National Park and the Catalan MPAs. What has been shown in the most accessible depth range (< 60 m) is the erosion of maximum sizes: branch height and more obviously the diameter at the base, much smaller on average than in a protected area (Garrabou *et al.*, 2002).
- At a depth of 100 and even 150 m, the verification of the effects of manual harvesting becomes very complicated and technical (rebreather diving with gas mixtures, observations from ROV).

- Regardless of the fisheries impact assessment protocol implemented (see below), during each field trip, it is important to note the presence of illegal lost gear (St. Andrew's cross, Italian bar) and the number of red coral fragments scattered on the bottom.
- The presence of red coral fragments on the bottom is not necessarily due to fishing. Colony breakages can be caused by storms or by divers, for example.
- The assessment of the impact of fishing on the local coral population (decrease in abundance of commercial size coral colony branches-foot branches) can be done using several methods that can be combined, but here it's not about evaluating the community of which the coral is a part.
- Warning: the monitorings mentioned below only concern a very small superficial part of the area being exploited. Only ROVs can allow a more complete exploration, however, given the current state of the art, it remains illusory to follow the marks of colonies fished with the help of a ROV. However, we consider that data collection can still be carried out to preserve the memory of certain populations (careful archiving with date, place) and can be useful to experts without however replacing scientific work.
  - **Landscape monitoring.** Photographic shoots of sites where red coral is present are taken at regular intervals, every 3 to 5 years for example. The photos are then named, dated, geo-located and archived. Descriptive inter-annual comparisons make it possible to assess the evolution of the population.
  - **Monitoring by diving measurements** (Garrabou *et al.*, 2001). Monitoring can be done by permanent or random quadrants. Within each quadrat, the number of colonies is recorded, the maximum height measured (to within 2 mm), the number of branches and morphotype noted, and the mortality rate (using a template) recorded. If no quadrat is used, it is possible to make biometric measurements on a large number of colonies (~100) taken randomly in the same area. This protocol can be renewed every 3 to 5 years.
  - **Monitoring by photogrammetry** (Drap *et al.*, 2014). Monitoring can be done by permanent or random quadrants, by a diver or from an ROV. The photographs are taken using 2 cameras (flashes recommended) used at the same time (in manual mode) and oriented at 2 different angles, around 30°. The photos are named and archived. They are then integrated into image processing and 3D model construction software (e. g. Surveyor, Photoscan). The morphotype metrics, number of branches, basal diameter, size, mortality rate (using a template) are recorded for each colony encountered. The marks of fished colonies are recorded. This 'expert' protocol requiring equipment and specialists can be renewed every 3 to 5 years.
  - **Monitoring by ROV** in the deepest areas (Rossi *et al.*, 2008; Cattanea-Vietti *et al.*, 2017; RAMOGE, 2017; Yoklavich *et al.*, 2018). ROV routes along the walls allow to locate, count and describe the morphology of the colonies as well as the marks of fished colonies. Densities can be calculated with a scale or 2 laser pointers, which spacing is known, placed on the wall. If the image quality is very good, an estimate of the size of the colonies can be attempted (to within 2 cm or according to size categories). Due to the high costs, this protocol can be renewed every 10 years.
- Let's recall here that red coral is a species sensitive to global warming and can suffer massive mortality in the shallowest part of its populations (Garrabou *et al.*, 2001).

Implementation advice

- With regard to fishing effort and sampling assessments, the support of co-workers is essential. If access to the catch is possible, record at least the maximum size of the branches (measure several branches or take pictures with a scale), and, if possible, the total weight of the catch.
- Try to (set up) take occasional measurements if monitoring is not really possible (the fisher is then reassured not to disclose his total catch and therefore his annual turnover)
- Data confidentiality (anonymity, data aggregation, global restitution) must be ensured and guaranteed to the co-workers.
- The implementation of protocols for evaluating red coral populations must be done after advice and validation by scientists specialising in this species: choice of study stations, protocol (according to defined objectives), metrics.

Difficulties, advantages / Disadvantages

- The coral deposits that can now be exploited are often found in deep areas around -100 m
- Assessments of fishing effort and harvesting require the support of coral fishers or some coral fishers, but exploitation in the MPA may be subject to control of harvesting techniques and mandatory monitoring given the status of the species
- Scientific support is required for the implementation of stand monitoring protocols

Advantages

- The combination of several protocols and approaches can provide basic costed elements (but not necessarily coherent for management)
- Some protocols are relatively easy to implement and inexpensive (documentation, national statistics, landscape monitoring). Do not hesitate to solicit buyers, Torre del Greco companies, jewellers who know the market perfectly, explore the local marketing channel and periodically update this information
- The status of the species can provide a favourable framework for monitoring and support from the authorities in the face of poaching: Mediterranean countries have an interest in regulating coral fishing very seriously (threatening to give it CITES status)
- The involvement of coral fishers in monitoring may include disease monitoring, reporting on the environment and species occupying the same habitat, etc.

Disadvantages

- The practice of fishing for red coral remains opaque and little reliable information is available (often incorrect figures)
- In order to have consistent figures for management, the combination of several protocols and approaches must be considered, at least looking for 'floor' values = low estimates, as the available statistics only reflect very little of the reality of exploitation
- Deep living species = complications; some protocols are difficult to implement and can be costly (ROV monitoring)

Material

- For effort and harvest evaluations: see corresponding sheets
- Depending on the populations monitoring protocol:
  - means at sea (boat, pilot)
  - diving equipment and divers qualified for high depth
  - field equipment (notation slate, ruler, caliper)
  - cameras and associated flashes
  - ROV and pilot.

€ Estimated costs (€: low, €€: medium, €€€: high)

€ to €€€ Human resources
€ to €€€ Specific service for data collection
€ to €€€ Investment / material
€ to €€€ Data analysis

Administrative procedures, legal provisions

- Request for authorisation to dive in restricted areas, if applicable
- Request for access to local and national archives, fisheries statistics (including export), resellers books and data, etc.

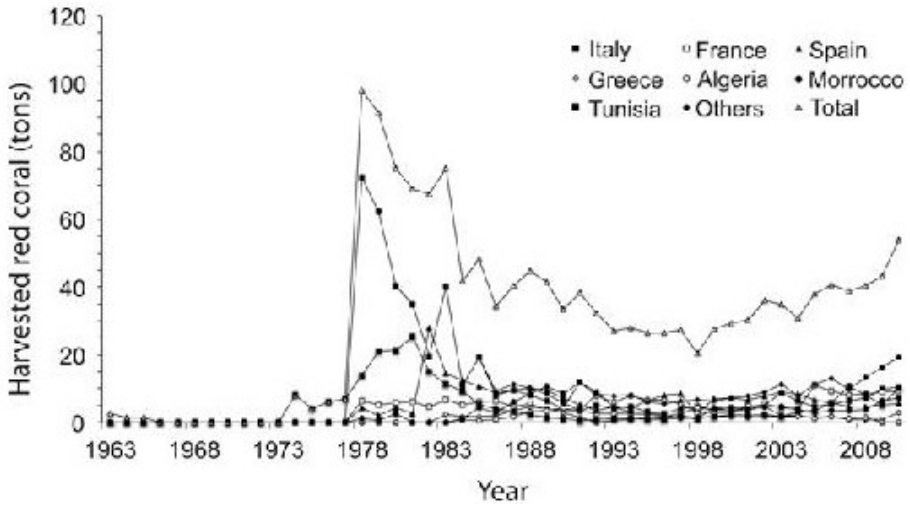
Type of results obtained / Metrics

- For metrics associated with effort and collection evaluation protocols, see the corresponding sheets
- Basic biometric metrics:
  - number of colonies fished
  - average, maximum and minimum height, basal diameter
  - the number of colonies / m² does not provide information on fishing effort. Very often, there is an aggregation of a huge number of small colonies (vault and walls of semi-dark caves, which are no longer commercially exploitable) (Harmelin pers. comm.)
  - number of living / dead colonies
- Derived metrics:
  - growth rate in mm / year
  - recruitment rate / year
  - rate of colonies fished / year
  - mortality rate / year

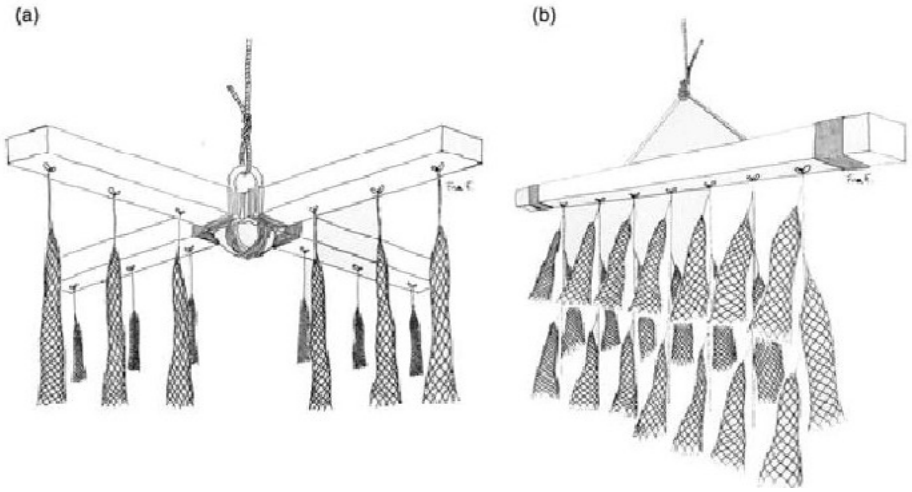
Graphical representations

See corresponding sheets for effort and harvesting evaluations

- Photos, videos and tables
- Biometric metrics histogrammes



Red coral fisheries surveys (in tons) in Mediterranean countries based on FAO data (Tsounis *et al.*, 2013)



Schematic representation of (a) the cross of Saint Andrew (Cattanea-Vietti *et al.*, 2017)

To go further

- Cattaneo-Vietti *et al.*, 2007. Illegal ingegno fishery and conservation of deep red coral banks in the Sicily Channel (Mediterranean Sea). Aquatic Conservation: Marine and Freshwater Ecosystems, 27: 604–616.
- Deidun *et al.*, 2010. Records of black coral (Antipatharia) and red coral (*Corallium rubrum*) fishing activities in the Maltese Islands. Marine Biodiversity Records, 3: 1-6.
- Garrabou *et al.*, 2001. Mass mortality event in red coral *Corallium rubrum* populations in the Provence region (France, NW Mediterranean). Marine Ecology Progress Series, 217: 263-272.
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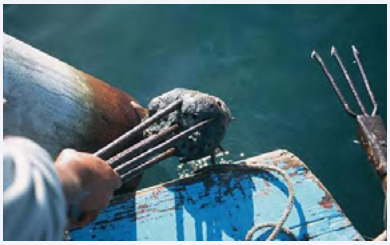
- RAMOGE, 2017. Campagne d'exploration des zones profondes/Deep-Sea Exploration Campaign. RAMOGE Ed.: 52 p.
- Rossi *et al.*, 2008. Survey of deep-dwelling red coral (*Corallium rubrum*) populations at Cap de Creus (NW Mediterranean). Marine Biology, 154: 533-545.
- Tsounis *et al.*, 2007. Red Coral Fishery at the Costa Brava (NW Mediterranean): Case Study of an Overharvested Precious Coral. Ecosystems, 10: 975-986.
- Tsounis *et al.*, 2013. Management hurdles for sustainable harvesting of *Corallium rubrum*. Marine Policy, 39: 361-364.
- Yoklavich *et al.*, 2018. Incidence of disturbance and damage to deep-sea corals and sponges in areas of high trawl by catch near the California and Oregon border. Deep-Sea Research Part II, 150: 156-163.

Assessment of the fishing effort of toilet sponges and their deposits



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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the approach and monitoring methods, acceptance of professionals
- Tool that can be implemented within the framework of a charter

REMARKS

The 2 main species concerned are: *Spongia (Spongia) officinalis* and *Hippospongia communis; Spongia (Spongia) lamella* and *Spongia (Spongia) adjimensis* can also be targeted by fishers. All are listed in Annex III of the Berne Convention and in Annex III of the Barcelona Convention.

This particular fishery can be difficult to apprehend and evaluate. The cross-referencing of several protocols can provide coherent costed elements for management.

Today, this fishing is only practiced in rare places in the Mediterranean. The fishers' home ports are Kalymnos (GR), Zarzis and Kerkennah Islands (TU), Krapanj (HR)

ACTIVITIES CONCERNED

Toilet sponge fishing

Objectives and expected results

Objectives

- Assess professional fishers site use
- Have information on the profile of professional sponge fishers working in or around the MPA: home port, working technique used (scuba diving, hookah diving, walking), working depth range, individual fisher with or without a boat, all equipment or ship owner employing divers
- Evaluate practices and samplings
- Know the spatial (fishing sites and / or deposits) and temporal (days, seasons, years) distribution of sampling
- Be able to superimpose this distribution with a habitat mapping
- Assess the impact of this fishery on populations
- Reconstruct the history of this fishery in the MPA
- Determine fishers' knowledge of the biological characteristics of the toilet sponge species they fish
- Understand the legal, economic and social context of sponge fishing: sales, processing and packaging channels, fishers' shops, illegal practices
- Identify the factors that determine the diversity of observed behaviours: the process of land appropriation, acceptance, adherence or rejection of certain management measures
- Manage the sustainability of this fishery as part of a management plan
- Assess the effect of regulating or prohibiting this fishery on part of the MPA territory (if applicable)

Expected results

- Quantitative assessments (number of vessels, fishers) of the effort of this fishery
- Typology of professional fishers (origin, seasonality of practices, other fishing activities practised (e.g. fishing for holothurians, bivalves)
- Techniques used (foot, apnea, hookah, snorkel, scuba, trident)
- Proportion of fishing carried out in and outside of MPAs
- Quantitative evaluations (% of different species, number, weight) of harvests carried out
- Quantified and spatialised elements to implement appropriate management measures
- Quantified elements of the impact of this fishery on populations (if applicable)
- Know how fishers perceive the state of the environment and the evolution of the resource

SAMPLING: TIME UNITS

See elements in the corresponding sheets when there is a reference or following the protocols presented in the section 'Protocol description'.

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around, if no-take zone or if effect of measured management) or if deposit in the vicinity

Monitoring subunits

- Management areas: integral protection and fisheries control zones (if applicable), favourable sites, colonies

FEEDBACK FROM EXPERIENCE

- Department of Fisheries and Marine Research of the Ministry of Agriculture, Natural Resources and Environment of the State of Cyprus (CY)

- Know how fishers see the effects / impacts of their own practices on the environment and the resource
- Know what views fishers have of the other actors in the MPA territory (other users, managers, decision-makers, associations, etc.): territories of practice, current and / or potential conflicts, responsibilities, etc.
- Determine the fishers' knowledge of the biology of toilet sponge species and the dynamics of stock recovery
- Determine the fishers' knowledge of the regulations and the different management actions within the MPA: understanding, acceptance / rejection, effectiveness, legitimacy, suggestion

Protocol description

- Sponge **fishing effort** assessment involves small boats suitable for diving harvesting and can be done from:
  - visual counts of fishing vessels from a boat / at sea or from the shore / ashore (see corresponding sheets)
  - declarations by a fishing logbook filled in by the fishers themselves (see corresponding sheet), at least of the quantity of sponges caught in the MPA: authorisation to operate under the condition that information is fed back
  - landing surveys (see corresponding sheet) including or not including fishers' perceptions
  - interviews that can also address perception, socio-economic and / or historical aspects (see corresponding fact sheets)

Note: Fishing seasons, dive times and / or time spent at sea annually are important information to be recorded.

- The assessment of sponge fishing effort can also be based on **measurements at traders, vendors' stores** (Economou *et al.*, 1990). The sponges are identified by species, measured (maximum diameter) and weighed. For each lot sampled (usually from at least the same fisher or region), information on the fishing location, technique used, environmental conditions must be provided. It is sometimes difficult or even impossible to make this link (easier to make if you sample at landings).
- Consultation of **national statistics** with the authority in charge of controlling this fishery, and / or with traders, packaging workshops, can provide a wealth of quantitative information on collections (species, count, weight), the number of fishing licences, fishers (Economou *et al.*, 1990) and / or fishers practising fishing in the MPA region. These consultations can ideally be carried out every year (consultation of lists of licences issued, annual statistics), otherwise at regular intervals and reported in a notebook or digital tracking file.
- The assessment of the impact of this fishery on the populations cannot be done by **landscape monitoring** because the identification of species in photographs is difficult or even impossible. Identification can only be done by sampling and for some species by *in situ* observations by taxonomists.
- However, the impact of this fishery on populations can be assessed through **diving measurements**. Monitoring is based on permanent quadrats (after ensuring that the colonies are properly identified by a taxonomist). Within each quadrat, colonies are identified (species, morphotype), measured (maximum diameter) and mortality rate (using a template) recorded. This protocol can be renewed every 3 to 5 years

Implementation advice

- Concerning the assessments of fishing effort and catches, the support of sponge fishers is essential (at least a few to be able to work). It is desirable to involve them in the implementation of the protocol from the very beginning.
- Data confidentiality (anonymity, data aggregation, global restitution) must be ensured and guaranteed to fishers.
- To compensate for the lack of quantitative or economic data concerning this activity, the perception survey is useful. The question 'Are you looking for new fishing sites?', for example, can be used to report on exploitation limitations conditions.
- The implementation of protocols for evaluating sponge populations must be done after advice and validation by specialised scientists: identification of species, choice of study sites, protocol (according to defined objectives), metrics.
- Monitoring the impact of fishing on the resource can be difficult in Greece (low density on sites, slow growth) but possible in Tunisia (high density on sites, faster growth) (Fourt, pers. comm.).
- There are fishing schools (Kalymnos and Zarzis for sponges) where awareness can be raised and monitoring support provided.

Difficulties, advantages / Disadvantages

- Population monitoring protocols cannot be implemented everywhere: environmental conditions (temperature, currents, nutrients) determine the presence or absence of sponges, species distribution, growth and density. There are intraspecific differences between geographical areas, particularly with regard to weight (Fourt, pers. comm.). In addition, sponges are taxa that can suffer significant mortality from diseases but also from climate change (Vacelet, 1994; Pronzato, 1999; Perez *et al.*, 2014).
- Sponge fishers can also fish for holothurians. The same monitoring can therefore simultaneously provide information on these different practices and catches.
- Fishers cover large areas during their fishing season. They therefore have a regional vision of the distribution of species, habitats or particular events. In addition, it is not uncommon for them to see curious Monk Seals *Monacchus monacchus*. These fishers can act as sentinels and provide useful information for MPA managers.

Advantages

- The cross-referencing of several protocols and approaches can provide more precise costed elements for management
- Some protocols are relatively easy to implement and inexpensive (local and national statistics, annual number of fishing licences). Do not hesitate to solicit buyers, resellers as well, explore the local marketing channel and periodically update these information
- The involvement of sponge fishers in monitoring may include monitoring sponge diseases, providing information on the environment and species occupying the same habitat, other target species (holothurians, bivalves), etc.

Disadvantages

- Because of the specific nature of their activity, the assessment of fishing effort, like that of the state of populations, requires the support of sponge fishers and they may not easily share their knowledge (fishing sites, quantities fished)
- Access to actual collection data can be difficult
- Available statistics do not always sort species and do not always reflect the reality of exploitation. Weight (kg) assessment is less accurate than the number in terms of monitoring

Material

- For effort and collection evaluations: see corresponding sheets
- For the population monitoring protocol:
  - means at sea (boat, pilot)
  - diving equipment and divers
  - field equipment (scoring slate, rule)
  - cameras and associated flashes
  - sampling equipment for identification purposes.

€ Estimated costs (€: low, €€: medium, €€€: high)

€ à €€€	Human resources
€ à €€€	Specific service for data collection
€ à €€€	Investment / material
€ à €€€	Data analysis

Administrative procedures, legal provisions

- Request for authorisation to access local and national archives, fishery statistics (including export statistics), traders' books and data, etc.
- Request for authorisation to dive in restricted areas, if applicable

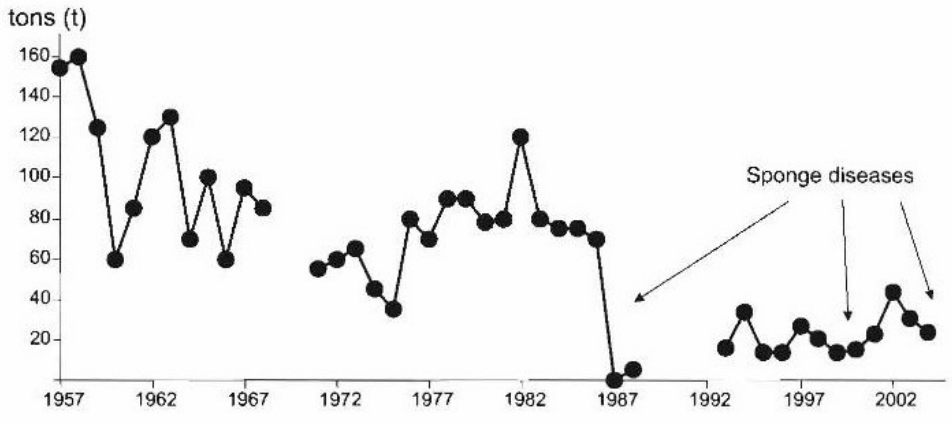
Type of results obtained / Metrics

- For metrics associated with effort and collection evaluation protocols, see corresponding sheets
- Basic metrics :
  - number of licences, fishers
  - fishing technique used
  - species collected, number, weight, size
- Derived metrics :
  - number of licences, fishers by area, per year
  - use proportion of the different techniques by area, per year
  - number of sponges collected per species, per area, per year
  - weight of sponges collected per species, per area, per year
  - average size of sponges collected per species, per area, per year

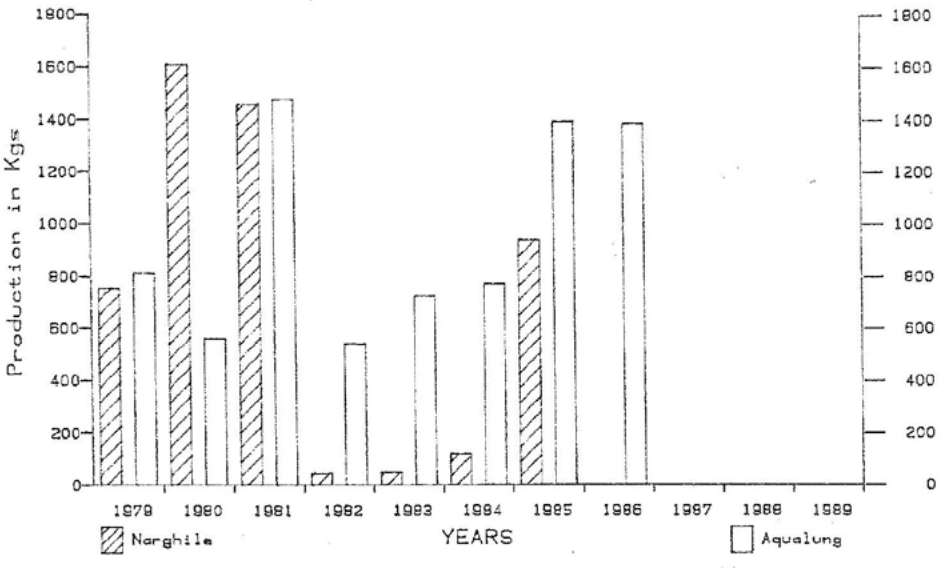
Graphical representations

- See corresponding sheets for effort and collection evaluations
- Photos of the sponges collected
- Tables, histogrammes of biometric metrics

Surveys of sponge fisheries (in tonnes) in Tunisia between 1957 and 2004 (© Perez *et al.*, 2014)



Quantity (in kg) of sponges caught by fishing technique (hookah or scuba diving here aqualung) between 1979 and 1989 in Cyprus (© Economou *et al.*, 1990)



To go further

- Economou *et al.*, 1990. Sponge fishery in Cyprus 1900-1989. Ministry of Agriculture and Natural Resources, Department of Fisheries. 50 p + 2 annexes.
- Perez *et al.*, 2014. Effect of climatic and anthropogenic disturbances on sponge fisheries. In: Goffredo S., Dubinsky Z. (Eds.), The Mediterranean Sea: Its History and Present Challenges. Springer Science & Business Media: 577–587.
- Pronzato, 1999. Sponge-fishing, disease and farming in the Mediterranean Sea. Aquatic Conservation: Marine and Freshwater Ecosystems, 9: 485-493.
- Vacelet, 1994. Control of the severe sponge epidemic Near east and Europe: Algeria, Cyprus, Egypt, Lebanon, Malta, Morocco, Syria, Tunisia, Turkey, Yugoslavia. Technical Report: The struggle against the epidemic which is decimating Mediterranean sponges, FI: TCP/RAB/8853, FAO, Rome, 39 p.
- http://www.marinespecies.org/porifera/

Assessment of the fishing effort of holothurians and their populations

© GIS Posidonie

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the approach and monitoring methods, acceptance of professionals
- Tool that can be implemented within the framework of a charter

REMARKS

The main species concerned are: *Holothurie tubulusa*, *H. polii* and *H. mammata*, all classified as minor concerns on the IUCN Red List.

This particular fishery can be difficult to apprehend and evaluate. The cross-referencing of several protocols can provide coherent costed elements for management

Holothurian fishing is mainly practised in Turkey (since 1996), Spain, Greece and Italy, to a lesser extent in Tunisia. But with the strong Asian demand, this fishery tends to develop (strongly) in the Mediterranean.

ACTIVITIES CONCERNED

Fishing for holothurians

Objectives and expected results

Objectives

- Assess the use of the site by professional fishers
- Have information on the profile of professional fishers fishing for holothurians and working in or around the MPA: home port, working technique used (scuba diving, hookah diving), working depth range, individual fisher with or without a boat, all equipment or ship owner employing divers
- Know the spatial (fishing sites) and temporal (days, seasons, years) distribution of the samples
- Be able to superimpose this distribution with a habitat mapping
- Identify the presence of illegal fishing in the MPA (prohibited area, non-compliance with the fishing schedule if applicable)
- Assess the impact of this fishery on populations
- Reconstruct the history of this fishery in the MPA (photos, testimonies - see factsheets dedicated to the historical investigation - and interviews with old fishers)
- Determine fishers' knowledge of the biological characteristics of the holothurian species they fish
- Understand the legal, economic and social contexts that drive fishers to engage in this new fishery, but also sales channels, processing and packaging, illegal practices
- Identify the factors that determine the diversity of observed behaviours: the process of land appropriation, acceptance, adherence or rejection of certain management measures
- Manage the sustainability of this fishery as part of a management plan
- Assess the effect of regulating or prohibiting this fishery on part of the MPA territory (if applicable)

Expected results

- Quantitative assessments (number of vessels, fishers) of the effort of this fishery
- Typology of professional fishers (origin, seasonality of practices, other fishing activities practised (e. g. sponge fishing, bivalve fishing)
- Techniques used (hookah, scuba gear)
- Proportion of fishing carried out in and outside of MPAs
- Quantitative evaluations (% of different species, number, weight) of harvests carried out
- Quantified and spatialised elements to implement appropriate management measures
- Quantified elements of the impact of this fishery on populations (if applicable)

SAMPLING: TIME UNITS

See elements in the corresponding sheets when there is a reference or following the protocols presented in the section 'Protocol description'.

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around if no-take zone or if measured management effect

Monitoring subunits

- Management areas: full protection and fisheries regulatory areas (if applicable), favourable sites

FEEDBACK FROM EXPERIENCE

- Directorate General of Fisheries and Aquaculture and Ministry of Food, Agriculture and Livestock of Turkey (TR)

- Know how fishers perceive the state of the environment and the evolution of the resource
- Know how fishers see the effects / impacts of their own practices on the environment and the resource
- Know what views fishers have of the other actors in the MPA territory (other users, managers, decision-makers, associations, etc.): territories of practice, actual and / or potential conflicts, responsibilities, etc.
- Determine the fishers' knowledge of the biology of holothurian species and the dynamics of stock recovery
- Determine the fishers' knowledge of the regulations and the different management actions within the MPA: understanding, acceptance / rejection, effectiveness, legitimacy, suggestion

Protocol description

- The assessment of holothurian **fishing effort** involves small boats suitable for dive harvesting and can be done from (González-Wangüemert *et al.*, 2014):
  - visual census of fishing vessels from a boat / at sea or from the shore / on land (see corresponding sheets)
  - declarations by a fishing logbook filled in by the fishers themselves (see corresponding sheet), at least of the quantity of holothurians caught (gutted weight) in the MPA: authorisation to exploit subjected to actually providing information
  - landing surveys (see corresponding sheet; species total length and gutted weight) including or not fishers' perceptions
  - interviews that can also address perception, socio-economic and / or historical aspects (see corresponding fact sheets).
- The holothurian fishing effort assessment can also be based on **measurements at traders and packaging plants**. Holothurians are identified by species, measured (total length gutted) and weighed (gutted weight). For each individual sampled, information on the fishing location, the technique used, the environmental conditions must be provided. It is sometimes difficult or even impossible to make this link (easier to make if you sample at landings).
- Consultation of **national statistics** with the authority responsible for controlling this fishery, and / or with fishing organisations, traders, packing plants can provide a wealth of quantitative information on harvests (species, count, weight), the number of fishing licences, fishers and / or fishers practising fishing in the MPA region. These consultations can ideally be carried out every year (consultation of lists of licences issued, annual statistics), otherwise at regular intervals and reported in a notebook or digital tracking file.
- The impact of this fishery on populations can be assessed using several methods that can be cross-referenced.
  - **Landscape monitoring**. Photographic / video shots of sites where holothurians are present in large numbers are taken at regular time intervals; every 3 to 5 years for example. The photos / videos are then named, dated, geolocated and archived. Descriptive inter-annual comparisons make it possible to assess the evolution of the population
  - **Diving measurement monitoring**. Monitoring is based on random quadrats (e. g. n = 30 ; 1 m^2), but can be based on random transects (e. g. n = 10 ; 20 m x 2 m). Within each transect / quadrat, species are identified and measured (maximum length). This protocol can be repeated every 3 to 5 years

Implementation advice

- Concerning the assessments of fishing effort and catches, the support of holothurian fishers is essential (at least some of them in order to be able to work). It is desirable to involve them in the implementation of the protocol, from the very beginning
- Data confidentiality (anonymity, data aggregation, global restitution) must be ensured and guaranteed to fishers

- The implementation of evaluation protocols for holothurian populations must be done after advice and validation by specialist scientists: identification of species, choice of study sites, protocol and methods (according to the defined objectives), metrics

Difficulties, advantages / Disadvantages

- Holothurian fishers can also fish for toilet sponges. The same monitoring can therefore simultaneously provide information on these different practices and catches.

Advantages

- The crossing of several protocols and approaches can provide more precise costed elements for management
- Some protocols are relatively easy to implement and inexpensive (local and national statistics, annual number of fishing licences). Do not hesitate to call on buyers, including resellers, explore the marketing channel and periodically update this information

Disadvantages

- Because of the specific nature of their activity, the assessment of fishing effort, like that of the state of populations, requires the support of holothurian fishers and they may not easily share their knowledge (fishing sites, quantities fished)
- Access to actual harvesting data can be difficult
- Available statistics do not always sort the species and do not always reflect the reality of exploitation

Material

- For effort and harvesting evaluations: see corresponding sheets
- For the population monitoring protocol:
  - means at sea (boat, pilot)
  - diving equipment and divers
  - field equipment (scoring slate, rule)
  - cameras / videos and associated flashes

€ Estimated costs (€: low, €€: medium, €€€: high)

€ to €€€ Human resources
€ to €€€ Specific service for data collection
€ to €€€ Investment / material
€ to €€€ Data analysis

Administrative procedures, legal provisions

- Request for authorisation to access local and national archives, fishery statistics (including export statistics), traders' books and trade data, etc.
- Request for authorisation to dive in restricted areas, if applicable

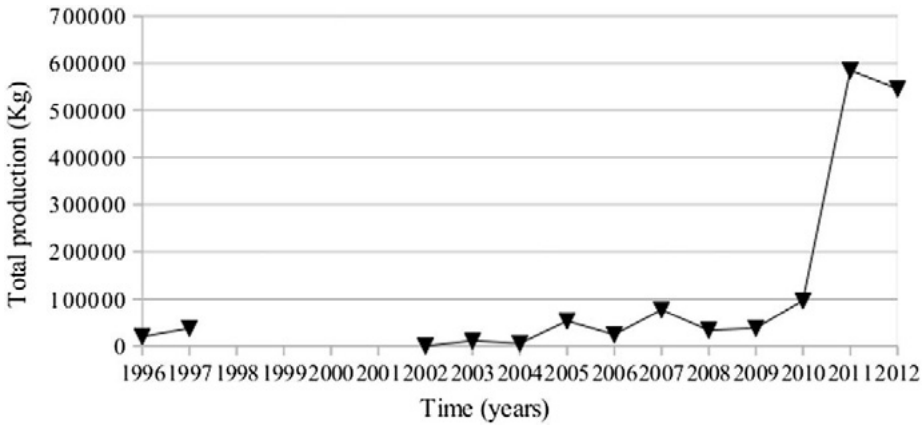
Type of results obtained / Metrics

- For metrics associated with effort and harvesting evaluation protocols, see corresponding sheets

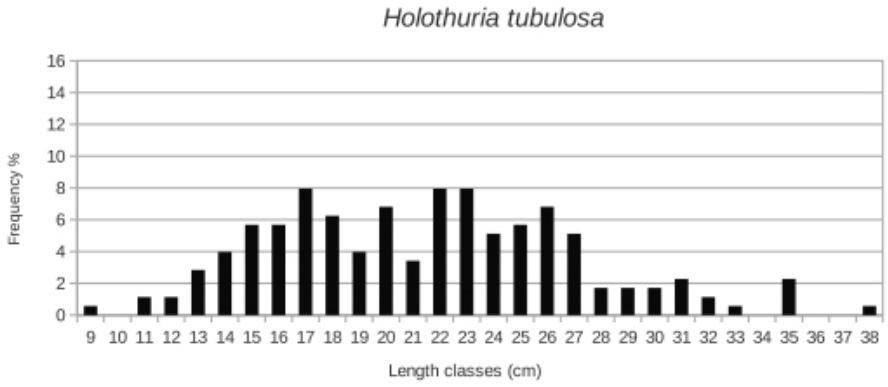
- Basic metrics :
  - number of licences, fishers
  - fishing technique used
  - species harvested, number, weight, size
- Derived metrics :
  - number of licences, fishers by area, per year
  - proportion of use of the different techniques by area, per year
  - number of holothurians harvested per species, per area, per year
  - weight of holothurians harvested by species, zone and year
  - average size of holothurians harvested per species, per area, per year

Graphical representations

- See corresponding sheets for effort and harvesting evaluations
- Photos and videos
- Tables, histogrammes of biometric metrics



Total production (in kg) of holothurian fishing in Turkey. For the period 1996-1997, the data concern *Paratichopus regalis*, and for the period 2002-2012, they concern *H. polii, H. tubulosa* and *H. mammata* (González-Wangüemert *et al.*, 2014)



Frequency (in %) of length classes (in cm) of *Holothuria tubulosa* targeted by fishing (González-Wangüemert *et al.*, 2016)

To go further

- Aydin, 2008. The commercial sea cucumber fishery in turkey. SPC Beche de Mer Information Bulletin, 28: 2 p.
- González-Wangüemert *et al.*, 2014. Assessment of sea cucumber populations from the Aegean Sea (Turkey): First insights to sustainable management of new fisheries. Ocean & Coastal Management, 92: 87-94.
- González-Wangüemert *et al.*, 2016. Setting preliminary biometric baselines for new target sea cucumbers species of the NE Atlantic and Mediterranean fisheries. Fisheries Research, 179: 57-66.

Assessment of the fishing effort of octopuses and their populations

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the approach and monitoring methods, acceptance of professionals
- The tool that can be set up within the framework of a specific charter or regulation

REMARKS

The main species concerned is *Octopus vulgaris* and to a lesser extent *Eledone cirrhosa* and *E. moschata*.

This particular fishery can be difficult to apprehend and evaluate. The cross-referencing of several protocols and information sources can provide coherent costed elements for management.

ACTIVITIES CONCERNED

Octopus fishing

Objectives and expected results

Objectives

- Assess the use of the site by professional and recreational fishers
- Have information on the profile of professional and recreational octopus fishers working in or around the MPA: home port and fishing techniques used (gargoyle, net, fishing rod, spear gun, trident, etc.), working depth range, individual fisher with or without a boat, all equipment or owner employing professional fishers
- Know the spatial (current and / or formerly exploited fishing sites) and temporal (days, seasons, years) distribution of the samples
- Be able to superimpose this distribution on a habitat mapping
- Identify the presence of illegal fishing in the MPA (forbidden area, non-compliance with the fishing schedule if applicable)
- Assess the impact of this fishery on populations
- Reconstruct the history of this fishing in the MPA (photos, testimonies - see fact sheets dedicated to the historical investigation - and interviews with old fishers)
- Determine fishers' knowledge of the biological characteristics of the species they fish
- Understand the legal, economic and social contexts of this fishery, but also the sales channels, processing and packaging, illegal practices
- Identify the factors that determine the diversity of observed behaviours: the process of land appropriation, acceptance, adherence or rejection of certain management measures
- Manage the sustainability of this fishery as part of a management plan
- Assess the effect of regulating or prohibiting this fishery on part of the MPA territory (if applicable)

Expected results

- Fishing effort quantitative assessments (number of vessels, fishers)
- Typology of professional fishers (origin, seasonality of practices)
- Techniques used (gargoyle, net, fishing rod, spear gun, trident)
- Proportion of fishing carried out in and out of the MPA
- Quantitative assessments (% of different species, number, weight) of catches made
- Quantified and spatialised elements to implement appropriate management measures
- Quantified elements of the impact of this fishery on populations (if applicable)
- Know how fishers perceive the state of the environment and the evolution of the resource
- Know how fishers see the effects / impacts of their own practices on the environment and the resource

SAMPLING: TIME UNITS

See elements in the corresponding sheets or following the protocols presented in the section 'Protocol description'.

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around if no-take zone or if measured management effect

Monitoring subunits

- Management areas: full protection and fisheries control areas (if applicable), favourable sites

FEEDBACK FROM EXPERIENCE

- Marine Reserves of the Balearic Islands (ES)
- Fisheries Research Institute of NAGREF (GR)

- Know what views fishers have of the other actors in the MPA territory (other users, managers, decision-makers, associations, etc.): territories of practice, actual and / or potential conflicts, responsibilities, etc.
- Determine the fishers' knowledge of the species biology and the stock recovery dynamics
- Determine the fishers' knowledge of the regulations and the different management actions within the MPA: understanding, acceptance / rejection, effectiveness, legitimacy, suggestion.

Protocol description

- The evaluation of octopus **fishing effort** also concerns professional and recreational fishing boats as well as practices from the shore:
  - visual counts of fishing vessels from a boat/at sea or from the shore/ashore (see corresponding sheets)
  - declarations by a fishing logbook filled in by the fishers themselves (see corresponding sheets) of at least the quantity of octopus caught in the MPA
  - landing surveys (for professionals; see corresponding sheet; species and weight) including or excluding fishers' perceptions
  - interviews can also address perception, socio-economic and / or historical aspects (see corresponding fact sheets).
- Consultation of **national statistics** with the authority responsible for monitoring this fishery and / or with fisheries organisations can provide a wealth of quantitative information on catches (species, count, weight), the number of fishing licences, fishers and / or fishers practising fishing in the MPA region. These consultations can ideally be carried out every year (consultation of lists of licences issued, annual statistics), otherwise at regular intervals and reported in a notebook or digital tracking file.
- The impact of this fishery on populations can be assessed using several methods that can be cross-referenced:
  - **Diving measurements**. Monitoring is based on random or permanent transects (e. g. n = 10; 20 m x 2 m) in visual or video counts. Within each transect, the dens and species encountered are recorded and their estimated weight (example classes: < 50 g; 50-200 g; 200-500 g; > 500g) or the total length of the mantle. For dens, the presence or absence of individuals and eggs is noted. Consider noting the type of habitat being surveyed (boulders, pebbles, sand) and the depth range of the survey. This protocol can be renewed every 3 to 5 years.
  - **Scientific fisheries**. Sampling is carried out using fishing techniques (representative of those used in the area) such as nets or gargoyles. It should be standardised with an equivalent number of replicates and fishing times in each monitoring station (in and out of the MPA for example). For each individual caught, the species name, weight, total mantle length and sex are recorded. It is possible to take stomachs to qualify and quantify their content (attention: difficult to set up and requires particular skills, approach research organisations). The fishing characteristics are recorded: gear used, depth, setting time. This protocol can be renewed every 3 to 5 years.

Implementation advice

- With regard to fishing effort and catch assessments, the support of fishers, whether professional or recreational, is essential
- Data confidentiality (anonymity, data aggregation, global restitution) must be ensured and guaranteed to fishers
- The implementation of protocols for evaluating octopus populations must be done after advice and validation by specialised scientists: identification of species, choice of study sites, protocol and methods (according to the defined objectives), metrics

Difficulties, advantages / Disadvantages

Advantages

- Some protocols are relatively easy to implement and inexpensive (site use studies, local and national statistics, annual number of fishing licences)

Disadvantages

- The fishing effort assessment requires the support of fishers and they may not easily share their knowledge (fishing sites, quantities fished)
- Access to actual collection data can be difficult
- The available statistics do not always sort the species and do not always reflect the reality of exploitation
- Difficulty in meeting fishers on the dock during landing surveys because it is less regular and therefore more difficult to observe them during port visits

Material

- For effort and catch evaluations: see corresponding sheets
- According to the population monitoring protocol:
  - means at sea (boat, pilot)
  - diving equipment and divers qualified to go down deep
  - use of professional fishers to implement fishing gear in the context of scientific fisheries monitoring (remuneration may be considered)
  - field equipment (rating slate, ruler, scale)
  - camera and / or cameras with associated flashes

€ Estimated costs (€: low, €€: medium, €€€: high)

€ - €€€ Human resources
€ - €€€ Specific service for data collection
€ - €€€ Investment / material
€ - €€€ Data analysis

Administrative procedures, legal provisions

- Request for authorisation to access local and national archives, fishing (including export) statistics, etc.
- Request for authorisation to dive in restricted areas, if applicable
- Request for authorisation to board fishing vessels, if applicable

Type of results obtained / Metrics

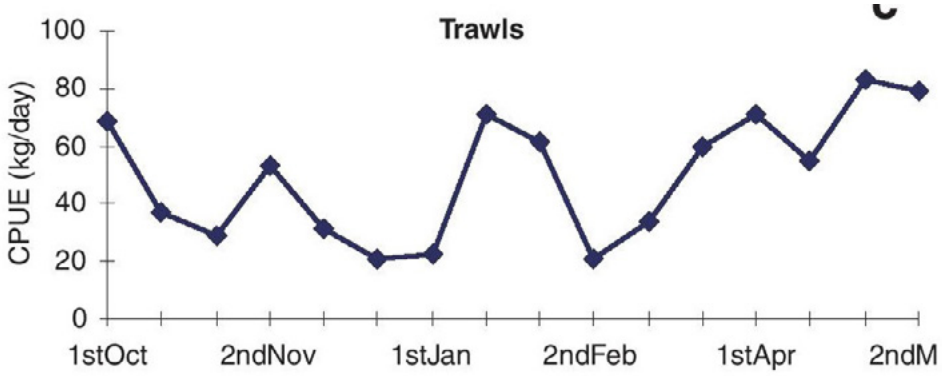
- For metrics associated with effort and catch evaluation protocols, see the corresponding factsheets
- Basic biometric metrics:
  - number of licences, boats, fishers
  - fishing technique used
  - species collected, number, weight
- Derived metrics:
  - number of licences, vessels, fishers by area, per year
  - proportion of use of the different techniques by area, per year
  - number of octopuses collected per species, per area, per year
  - weight of octopus taken per species, per area, per year

Graphical representations

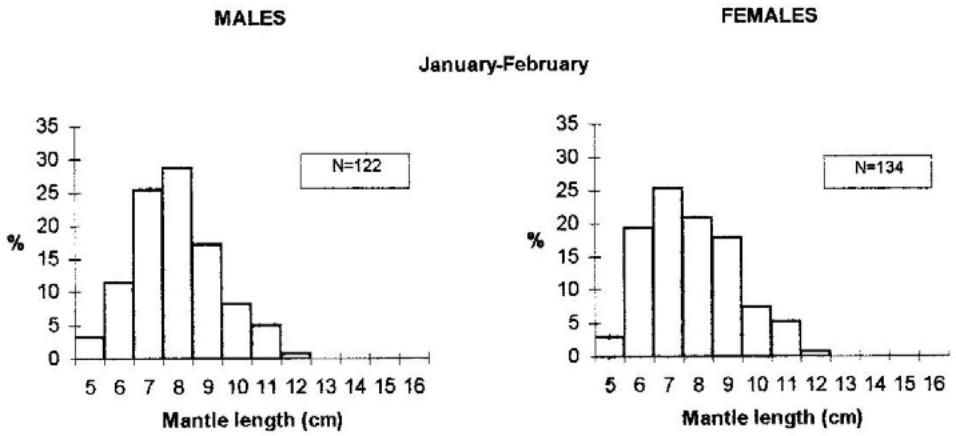
See corresponding sheets for effort and harvest evaluations

- Photos and videos
- Tables, histogrammes of biometric metrics

Catch per unit effort (in kg/day) of *Octopus vulgaris* caught by trawl in the Kevala and Limenas fisheries in Greece (Tsangridis *et al.*, 2002)



Demographic structure (length of mantle in cm) of *Octopus vulgaris* individuals caught by fishing (Quetglas *et al.*, 1998)



To go further

- Guerra *et al.*, 2015. Spawning habitat selection by *Octopus vulgaris*: New insights for a more effective management of this resource. Fisheries Research, 167 : 313-322.
- Katsanevakis *et al.*, 2006. Seasonal population dynamics of *Octopus vulgaris* in the eastern Mediterranean. ICES Journal of Marine Science, 63 : 151-160.
- Quetglas *et al.*, 1998. Biology and Fishery of *Octopus vulgaris* Cuvier, 1797, caught by trawlers in Mallorca (Balearic Sea, Western Mediterranean). Fisheries Research, 36 : 237-249.
- Sonderblohm *et al.*, 2017. Participatory assessment of management measures for *Octopus vulgaris* pot and trap fishery from southern Portugal. Marine Policy, 75: 133-142.
- Tsangridis *et al.*, 2002. Exploitation patterns of *Octopus vulgaris* in two Mediterranean areas. Scientia Marine, 66(1) : 59-68.

Interactions between fishing and habitats and species

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- In order to be able to study the interactions between fishing activities and habitats and species, it is essential to have a site use study (see corresponding sheets).

REMARKS

This sheet does not provide a standard method because the studies to be carried out depend on the type of fishing and the habitats and species concerned by the interaction. Key elements and examples are provided to guide the manager. The methods for monitoring the impact on fish populations using visual, video and acoustic methods are described in a sheet

ACTIVITIES CONCERNED

All of them

Objectives and expected results

Objectives

- Identify the pressures and impacts of professional and recreational fishing on habitats and species
- Know the spatial distribution (maps) of these pressures and impacts
- Be able to superimpose this distribution with maps of fishers' site use, natural habitats and species
- Better manage uses as part of a management plan
- Reduce pressures and impacts
- Evaluate the means to be put in place to carry out awareness-raising actions and promote sustainable behaviours

Expected results

- Qualitative assessments of the pressures and impacts of professional and recreational fishing practices (depending on the equipment of fishers, boats)
- Quantitative assessments: extent of pressures and impacts
- Location of impacted areas
- Vulnerable species

Protocol description

- Professional and recreational fisheries, like all activities, put pressure on the environment and can have an impact on the sustainability of the resource, marine habitats and species.
- The pressures of professional and recreational fishing on the environment can be combined with those of other activities. It is necessary to take into account the different activities present in the area to study these interactions.
- The impacts of fishing can be direct or indirect on the environment: results of targeted or incidental catches (non-targeted fish or elasmobranch species, birds, marine mammals, turtles or seals), damage to habitats (abrasion caused by gear, lost gear, trawl tracks) or species (modified behaviour, no kill practice, etc.).

SAMPLING: TIME UNITS

Monitoring periodicity

The protocol should take into account the seasonality of fishing practices and the biology and the ecology of the species

Frequency

Every 5 to 10 years

Duration

Variable, depending on the extent of the study site and the habitats/species studied

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA

FEEDBACK FROM EXPERIENCE

- Cap de Creus Reserve (ES)
- Calanques National Park (FR)
- http://medpan.org/main_activities/fishm-pablue2-project/

- To carry out a study on the interactions between fisheries and habitats / species, it is necessary to have a good knowledge of:
  - fishing practices and effort: fishing profiles, métiers / activities, gear, seasonality, duration and frequency of trips, spatial and temporal distribution
  - catches: target species, quantities fished (size, weight), by-catch, including birds, turtles, marine mammals
  - habitats and species present on the site: characterisation of the environment, habitat structure and functionality, sensitivity, stock status.
- The evaluation of site use is a prerequisite for evaluating interactions (see corresponding sheets) in order to:
  - identify whether fishing is carried out in areas of sensitive habitats, functional areas for certain species (breeding, nesting, calving areas for marine mammals, turtles or sharks and rays)
  - estimate fishing pressure, particularly on target species
  - identify potential areas of conflict between different activities carried out at the same place at the same time.
- The table below summarises the potential pressures generated by the different professional fishing métiers and recreational fishing activities (Le Fur, 2010; Maison, 2009).

Pressure categories	Pressures	Métier(s) and activity(ies) concerned
Physical	Wildlife and bird disturbance: noise disturbance, visual presence	All of them
	Resuspension of the sediment	Métiers practiced on the bottom, on-board, underwater fishing
	Trampling of habitats	All recreational fishing activities
	Damage to fixed organisms and habitats (anchors or fishing gear or other)	Métiers practiced on the bottom, all recreational fishing activities
	Boat Injuries	Métiers and activities from a boat
	Movement of organisms	Métiers and activities from a boat
	Macro-waste	All of them
Chemicals	Hydrocarbon contamination and other emissions	Métiers and activities from a boat
	Contamination with heavy metals and synthetic compounds	All of them
	Change in nutrient levels	Boat-based activities (leisure)
Biological	Introduction / propagation of pathogenic organisms	All of them
	Introduction / propagation of alien / introduced species	All of them
	Species harvesting (exploitation of the resource, bycatch, injuries caused by fishing gear)	All of them

- Each natural habitat has a different sensitivity to fishing pressures. The methodology developed by the French MNHN (La Rivière *et al.*, 2015, 2016) can be used to integrate this parameter into the assessments.
- The specific issue of identifying lost fishing gear can be the subject of special monitoring of the MPA as well as collection and awareness-raising operations (see the sheet entitled "Contribution of participatory sciences").

Implementation advice

- Beforehand, it is necessary to understand the different 'visions' of the stakeholders, namely:
  - manager's vision: site scale, statutes, management objectives, etc.
  - fishers' vision: target species, métiers / activities practiced, fishing gear, areas and periods of practice, relationships between professional and recreational fishers, etc.
  - vision of scientists according to disciplines, themes, fields of study.
- The acquisition of baseline data is necessary in order to compare exploited and non-exploited sites. Otherwise, statements from expert scientists may be used.
- It is important to place the pressure studied among the other pressures that affect the environment, whether they are of anthropogenic or natural origin. Interactions between pressures and habitats / species are often multifactorial.
- Favour long-term series for knowledge of interactions and the benefits for the environment of the management measures put in place.

Difficulties, advantages / Disadvantages

Advantages

- Good tool for cooperation, awareness raising, joint project between users and managers

Disadvantages

- Difficulties in discriminating between the origins of pressures
- Requires skills: rely on specialists and particular know-how both in the definition of the sampling protocol and in the analysis of the data

Material

- Observation sheet containing the sampling strategy and the metrics to be recorded
- According to the protocol:
  - ruler, tape measure, quadrat
  - nautical means
  - diving equipment
  - camera, GoPro, binocular

€ Estimated costs (€: low, €€: medium, €€€: high)

€€€ Human resources
€€ Specific service for data collection
€ Investment / material
€€€ Data analysis

Administrative procedures, legal provisions

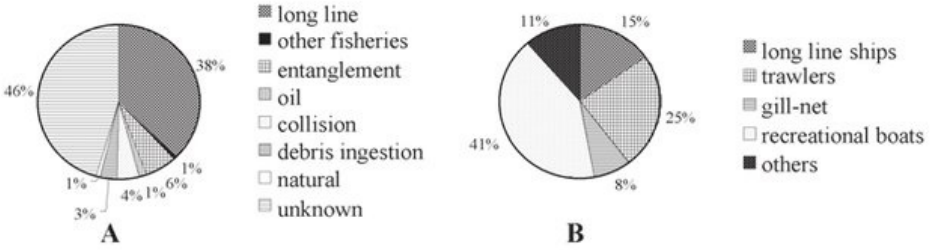
- Request for authorisation from the competent authorities in the case of sampling and / or handling of protected species

Type of results obtained / Metrics

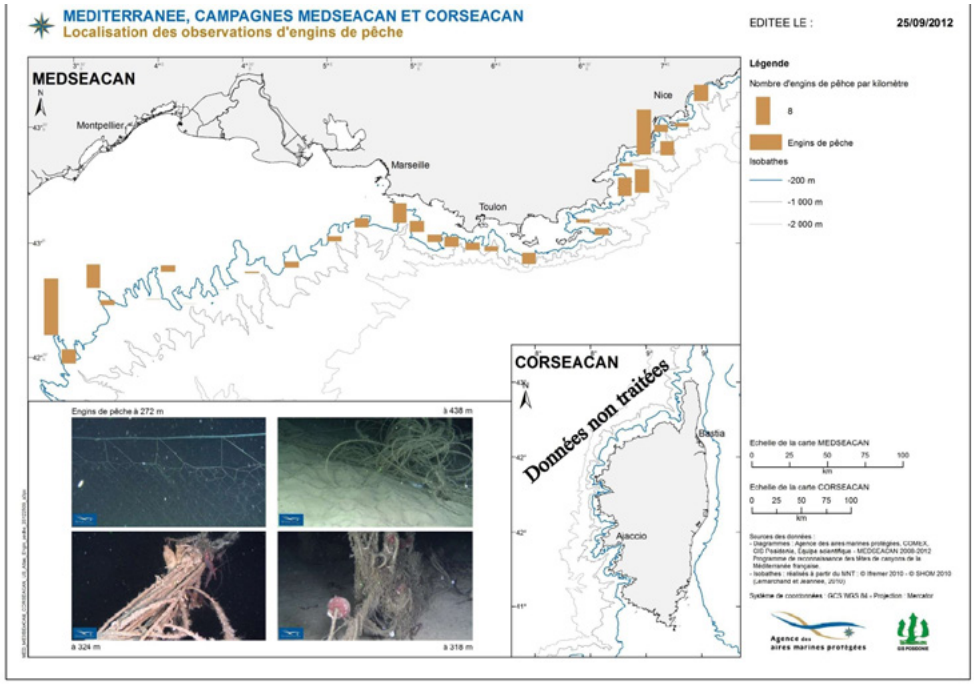
- Basic metrics:
  - number or weight of fishing gear or fishing waste collected during the annual monitoring
- Derived metrics:
  - average number of specific monitoring of fisheries / year interactions
  - number of monitoring categories on fisheries / year interactions
  - number of days of data acquisition / monitoring of fishing interactions / year

Graphical representations

- Tables, histogrammes of the metrics identified in relation to the pressure(s) studied
- Cross-reference maps between fishing pressures and the presence of habitats / species



Proportion of dead and alive *Caretta caretta* turtles stranded on the coast of Campania (Italy) after accidental fishing or impacts due to boats (© Bentivegna *et al.*, 2005, 2nd Mediterranean Conference on Marine Turtles)



Location of fishing gear observations during the MEDSEACAN campaign to explore underwater canyon heads (Fourt and Goujard, 2012)

To go further

- Arcos *et al.*, 2008. Fisheries Ecosystem Impacts and Management in the Mediterranean: Seabirds Point of View. American Fisheries Society Symposium 49: 1471–1479.
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- Carbonell *et al.*, 2003. The by-catch of sharks in the western Mediterranean (Balearic Islands) trawl fishery. Fisheries Research, 61: 7–18.
- Gamp *et al.*, 2016. Pêche récréative : un guide pour vous orienter dans vos méthodes de suivis – Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des aires marines protégées, Fr. : 199 p.
- La Rivière *et al.*, 2015. Méthodologie pour l'évaluation de la sensibilité des habitats benthiques aux pressions anthropiques. Rapport SPN 2015-69. MNHN. Paris, 52 p.
- La Rivière *et al.*, 2016. Evaluation de la sensibilité des habitats benthiques de Méditerranée aux pressions physiques. Rapport SPN 2015-70. MNHN. Paris, 101 p.
- Le Fur, 2010. Tome 1 Pêche professionnelle. Référentiel pour la gestion dans les sites Natura 2000 en mer – Activités, Interactions, dispositifs d'encadrement. Agence des aires marines protégées. 148 p.
- Lewison *et al.*, 2004. Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters, 7: 221-231.
- Lloret *et al.*, 2008. Spearfishing pressure on fish communities in rocky coastal habitats in a Mediterranean marine protected area. Fisheries Research 94: 84-91.
- Lloret *et al.*, 2008. Biological and socioeconomic implications of recreational boat fishing for the management of fishery resources in the marine reserve of Cap de Creus (NW Mediterranean). Fisheries Research, 91: 252-259.
- Lloret *et al.*, 2013. A comparative analysis between recreational and artisanal fisheries in a Mediterranean coastal area. Fisheries Management and Ecology, 20: 148-160.
- Lucchetti *et al.*, 2010. An overview of loggerhead sea turtle (*Caretta caretta*) bycatch and technical mitigation measures in the Mediterranean Sea. Reviews in Fish Biology and Fisheries, 20: 141-161.
- Maison, 2009. Tome 1 Sports et loisirs en mer. Référentiel pour la gestion dans les sites Natura 2000 en mer – Activités, Interactions, dispositifs d'encadrement, orientations de gestion. Agence des aires marines protégées. 220 p.
- Micheli *et al.*, 2013. Cumulative Human Impacts on Mediterranean and Black Sea Marine Ecosystems: Assessing Current Pressures and Opportunities. PLoS ONE 8 (12): e79889.

Diving assessments, fishing impact on habitats and species

Assessment of the impact of fishing on fish populations by visual census, video and acoustic recordings

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Know the spatial distribution of the different professional and recreational fishing activities (see corresponding sheets)
- Know how to identify fish species

REMARKS

The visual census of fish populations requires expertise. Unless internally competent, this work must be carried out by ecologists using these methods

ACTIVITIES CONCERNED

All of them

Objectives and expected results

Objectives

- Assess fish population in the management or fishing area
- Assess the impact of professional and recreational fishing on this population
- Be able to superimpose the assessment of the state of the population with a mapping of habitats and fishing efforts
- Locate areas of vulnerability
- Demonstrate the effect on populations of the prohibition or regulation of fishing practices by area = assessment of management measures for fishing in the coastal strip (mainly 0-40 m)
- Detect and / or evaluate the presence of poaching

Expected results

- Qualitative and / or quantitative assessments (species, abundance, biomass) overall, by target species in the coastal strip (<=40m). Beyond this depth, scientific fisheries may be undertaken with nets, trawls, longlines and with any type of gear to target the species or populations sought (see sheet 'Assessment of catches and associated effort by survey on board vessels').
- Figures and patterns of change showing the impact of this fishery on populations (density and size of target species, sex ratio, etc.)
- Quantified and spatialised elements to implement appropriate management measures

Protocol description

- Before starting any census, it is necessary to know and know how to identify the species present on the territory you wish to evaluate. For each species, it is then necessary to know if it is a species targeted by professional fishing (nets, longlines, traps) and recreational fishing (angling, underwater fishing or other). The protocols related to the evaluation of activities, effort and catches provide some answers (see survey sheets).
- A count sheet must be prepared in advance. In addition to the characteristics of the dive (date, observer, site name, weather), it includes a list of species that are likely to be encountered during the counts. This list can be defined with ecologists, fishers or divers who are familiar with the site. Provide empty lines to add names of species that have not been pre-listed.
- The principle of counting is to note the species crossed during a dive trip: presence / absence or size (small, medium, large, or size with a given accuracy in cm). The higher

SAMPLING: TIME UNITS

Frequency

At least every 3 years, annual, seasonal depending on the question asked

Frequency

Hot season, counts ideally spread over 2 close periods of several days, and cold season

Duration

From 3 to 10-15 minutes per counting, varies according to the method chosen

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around

Monitoring subunits

- Management areas: full, partial protection, regulation of certain fishing activities
- Sub-areas determined by zoning or fishing hot spot

FEEDBACK FROM EXPERIENCE

- Marine Reserves of Formentera-Espardell, Medes Islands, Cabo de Palos (ES)
- Cerbère-Banyuls Natural Marine Reserve, Côte Bleue Marine Park, Port-Cros National Park (FR)
- Marine Protected Areas of Torre Guaceto and Tavolara (IT)
- Marine and Coastal Protected Areas of Tabarka and Kuriat Islands (TU)

the accuracy required, the more observer training is required. Even experienced counters must do size calibration dives with silhouettes and between observers to succeed in the evaluations. Submersible figures with silhouettes of different sizes can be made to calibrate the observations; otherwise, tests with 2 person must be made and the data compared and readjusted during preliminary tests.

- When they are carried out through scuba diving, the counts are always done in pairs. Care should be taken to be far enough away so as not to be in each other's way and count the same fish twice, but not too far away to ensure the required safety conditions at the depth of the counts.
- Fish population assessments by visual census can be done using several methods:
  - **Reference counting on measured transects (Harmelin-Vivien and Harmelin, 1975; Harmelin-Vivien *et al.*, 1985; Planes, 2005)**
  - Visual fish census is carried out on rocky bottoms between 5 and 15 m in scuba diving gear or between 0 and 5 m in snorkel. The fish population is assessed at the scale of each station from random transects (n ≈ 5 to 10 to 2 observers; 25 m long x 4 or 5 m wide in general, i.e. 100 or 125 m²) materialised by a graduated tape. All fish seen within this corridor are counted, either on the bottom or in the water column. During the counting, each observer identifies, counts and evaluates the size according to the possible precision (within 2 cm, recommended) of all the species encountered. Cryptic species, especially small ones (mainly gobiidae, blennidae and tryptergidae) are not counted because they are not properly evaluated by this method. Macroinvertebrates of fishing interest (cephalopod molluscs and decapod crustaceans) are identified. On the way back, by rewinding the measured tape, the large but not very visible benthic species (mostelle, capon, conger eel) are counted, using a light. Depending on the objectives of the monitoring, it is possible to add during this return journey a habitat characterisation by small segments (5 m x 5 m for example): the nature of the substrate (percentage of overlap of 4 categories of substrate : rock, herbarium, sand, and gravel, the total = 100%) and the number and size of boulders encountered estimated by 3 categories ('small' <1 m,'medium' from 1 to 2 m and 'large' >2 m in diameter) in order to be able to take into account the habitat parameter in the data analysis (see section 'Difficulties, advantages / Disadvantages').
  - **Simplified counting of target species over time (Daniel *et al.*, 2002)**
    From a list including a selection of target species (see first point of the protocol), the fish encountered are noted (presence / absence), either in the small / medium category, or in the large category, or both. The limits are defined in advance (see FishBase: www.fishbase.org). For target species of underwater fisheries, such as groupers (*Epinephelus spp*.), corb (*Sciaena umbra*) and wrasse (*Labrus spp*.), the number of individuals of each species and their size (to the nearest 2 cm, and 5 cm for groupers) are specified. The counts are carried out on random routes (n ≈ 20 to 2 observers) timed (3 to 5 minutes maximum, width 5 m). The swimming is slow and must always be done at the same speed, even when there are no fish. A calibration between observers is necessary and the distance covered during the time of a count must be evaluated and remain constant so as not to distort the evaluation.
  - **Simplified counting by geo-referenced random transect "Tracked Roaming Transect" (Irigoyen *et al.*, 2018)**
    This method makes it possible to identify the species and density of individuals of each species without size assessment. This protocol was developed on the basis of monitoring of 6 emblematic species of the western Mediterranean that are particularly targeted by professional and recreational fishing, and which respond well to the effects of protection (*Epinephelus marginatus, E. costae, Mycteroperca rubra, Dentex dentex, Sciaena umbra, Mylobatis aquila*). An observer tows a GPS on a surface buoy such as a body board (making sure the buoy is always above him) along a random transect. The route travelled is recorded in the GPS, which allows the distance travelled to be calculated and geo-located by post-processing the GPS data. A second observer photographs the individuals met. Beforehand, the camera settings (date and time) are calibrated with those of the GPS. In post-processing, the photos taken can be "geo-tagged". The fish photographed are identified with the species and counted.
  - **Video counting (Pelletier *et al.*, 2012)**
    The counts are carried out from an underwater video system. The system consists of a weighted tripod and a waterproof housing containing a High Definition video camera as well as a timer for automatic activation at programmed intervals and durations. The video system can be composed of a single fixed or rotating camera or several cameras allowing to film in 360° at the same time. The video system is positioned at each study station by underwater divers on horizontal surfaces. It can be immersed for several

days (depending on the battery life) and filmed at several times of the day (morning, midday, evening). For each time sequence, each individual present on the image is visually identified by an observer to the highest possible level of taxonomy. This protocol provides data on species (but remains limited by difficulties in retrospective identification on video), abundance, behaviour (e.g. feeding, swimming, etc.), but does not allow biomass assessments (because it is not possible to estimate the size of individuals).

- **Acoustic method**
  Currently in full development, acoustic approaches can (in the near future) be used to discriminate between protected areas and fished areas by noise generated by fish assemblages. A protected area potentially has a different acoustic signature than a fished area due to the difference in fish assemblages. Some species with characteristic sounds (e. g. corb) can already be monitored; current research should make it possible to characterise the sounds of other fish species relatively quickly. For the moment, quantitative approaches are still difficult. These methods have mainly been used to monitor the fauna of hard substrate habitats in the Mediterranean. Many variations of these visual, video, photo and acoustic methods exist and correspond to adaptations to better sample certain species according to their behaviour, habitats (natural or artificial), the size of the species studied or the geomorphological characteristics of the sites: circular points for example, lengthening or shortening of transects according to the rarity of the species or the difficulty of observation in certain habitats. Transects can also be permanently fixed to the bottom using markers instead of being random at each station. There is an abundant scientific literature on these techniques.

- After the counts, it is imperative to check and validate the data entered on the card: be sure to have noted everything (date, site name), to be able to read again, that the 2 observers did not count the same fish (eliminate duplicates), adjust the numbers and sizes (possible over / under-evaluations). For photo and video data, referencing is essential and backups must be provided on hard disks stored in a safe place.
- The data from the sheets are then entered into an Excel® spreadsheet or database. Allow time for verification of the data entry (validation step), ideally by someone different from the person who entered the data.
- Fish biomass per unit area can be calculated from observed sizes using size / weight relationships from the literature (FishBase: www.fishbase.org).

Implementation advice

- Counts should preferably be carried out during the warm season (late summer August / September in the northwestern part), which is the period when the fish population is most abundant, the most diversified and stable
- As far as possible, carry out the counts on 2 different but close dates to take into account the temporal variability that may exist during the same season (strong winds that temporarily cool the water)
- Do not hesitate to throw out the first counts and lose a day at the beginning of the monitoring to improve accuracy. Regular visual counts are the best guarantee of the method's success. The dive must be exclusively dedicated to counting.
- Video and acoustic methods are not, for the moment, as efficient as visual counts (reference and simplified) in accuracy (sizes), but they should evolve positively in the future with advances in fundamental research and size identification and recognition software. Keep abreast of technological improvements; positioning yourself as a pilot site with scientists as part of research programmes can be interesting.
- These methods are interesting in all conditions where diving is difficult: high frequency monitoring, night or twilight observations (infrared cameras), in depth. Less observer bias.

Difficulties, advantages / Disadvantages

- The choice of stations based on depth and habitat is important. Habitat characterisation is interesting in this type of monitoring because habitat parameters significantly structure the population and can mask some results related to the management measures that are to be highlighted.

- Define the questions you want to answer and the metrics you want to follow because not all the protocols presented give access to all the metrics (e.g. biomass).

Advantages

- Metrics such as average density and especially average biomass clearly distinguish between fished areas and protected areas
- In the north-western Mediterranean,'indicator' species respond well to fishing pressures (e.g. sparids for professional fishing, *S. umbra* and *Epinephelus spp*. for underwater fishing, *Serranus cabrila* and *Coris julis* for angling), equivalents exist in the eastern Mediterranean

Disadvantages

- Diving and fish census skills required; depending on the team's skills and time available, using just internal staff may be difficult; working with scientists; additional costs to be expected (hosting supervised and trained students can help to achieve this)
- Interesting methods in the long term and if practiced with rigour and regularity
- Statistical analyses of the data to be forecasted

Material

- Scorecard sheet
- Graduated tape (decameter, wind-up pentameter), stopwatch
- Free diving or scuba diving equipment
- Boat and pilot, GPS
- Photo camera or video camera in case of doubt about the identification of a species and for the protocol if necessary
- Species Identification Guide

€ Estimated costs (€: low, €€: medium, €€€: high)

€€ Human resources

€€ Specific service for data collection (call for observers familiar with the protocols) and **€€€€** if in addition external service for the design of a database or analysis

€ Material purchase and implementation costs

€€ Desirable partnership with scientists

Administrative procedures, legal provisions

- Authorisation to access areas where diving is prohibited, if applicable

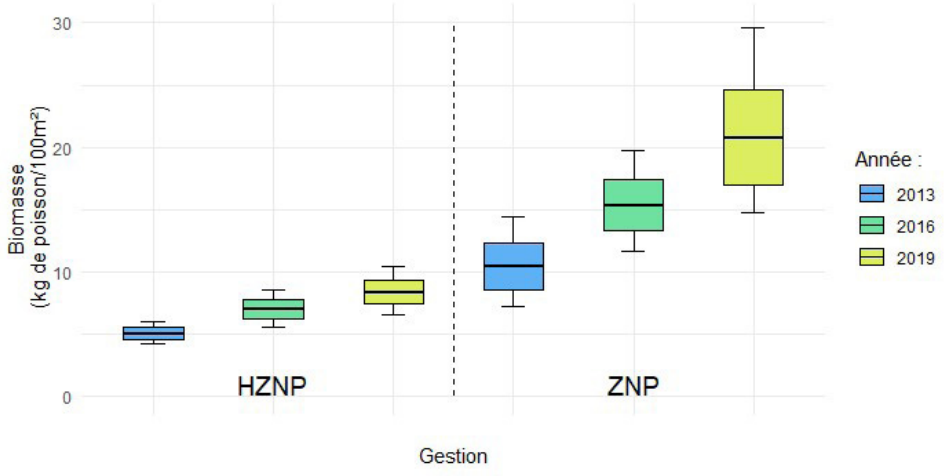
Type of results obtained / Metrics

- Basic metrics:
  - occurrence of species
  - specific wealth
  - abundance by species and total
  - individual size
- Derived metrics:
  - average occurrence of species / site, by management mode
  - average specific wealth / site, by management mode
  - average species / family density: total per site, by management mode

- average size of individuals for the most abundant species / site, by management mode
- average species / trophic category biomass by site, by management mode

Graphical representations

- Tables, diversity histogrammes, occurrence, species density and biomass, species size distribution.



Average fish biomass (kg of fish/100 m²) by management mode (HZNP: out of no take zones and ZNP: no take zone) in 2013, 2016 and 2019 (Le Diréach *et al.*, 2019)

To go further

- Daniel *et al.*, 2002. Note d'étape sur la méthodologie d'un « indice poisson » testé sur la Côte Bleue. 5 p.
- Guidetti *et al.*, 2014. Large-Scale Assessment of Mediterranean Marine Protected Areas Effects on Fish Assemblages. PLoS ONE, 9, e91841.
- Harmelin-Vivien *et al.*, 1975. Présentation d'une méthode d'évaluation "in situ" de la faune ichtyologique. Travaux scientifiques du Parc national de Port-Cros, 1 : 47-52.
- Harmelin-Vivien *et al.*, 1985. Evaluation visuelle des peuplements et populations de poissons : méthodes et problèmes. Revue d'Ecologie (Terre et Vie)., 40 : 467-539.
- Harmelin-Vivien *et al.*, 2008. Gradients of abundance and biomass across reserve boundaries in six Mediterranean marine protected areas: Evidence of fish spillover? Biological Conservation, 141: 1829-1839.
- Irigoyen *et al.*, 2018.The "Tracked Roaming Transect" and distance sampling methods increase the efficiency of underwater visual censuses. PLoS ONE 13(1): e0190990.
- Le Diréach *et al.*, 2019. Suivi de l'ichtyofaune du Parc national des Calanques à T0+6 - Année 2019. Rapport final. Marché public GIS Posidonie/Parc national des Calanques. GIS Posidonie publ., Marseille, Fr. : 176 p.
- Pelletier *et al.*, 2012. Remote high-definition rotating video enables fast spatial survey of marine underwater macrofauna and habitats. PLos ONE, 7(2): e30536.
- Planes, 2005. Final report BIOMEX: Assessment of biomass export from marine protected areas and its impacts on fisheries in the Western Mediterranean Sea. Project – UE – QLRT-2001-0891. BIOMEX, Perpignan, France, 503 p.

Diving assessments, fishing impact on habitats and species

Assessment of the impact of fishing on urchin populations

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Know the spatial distribution of professional and recreational urchin fishing (see corresponding fact sheets)

REMARKS

The 2 main species concerned are: *Paracentrotus lividus* and *Arbacia lixula*. Fishing for these species may be subject to national, regional and MPA-specific regulations (mesh, fishing period, quotas, type of fishing)

ACTIVITIES CONCERNED

Sea urchin fishing (grab tool, apnea, hookah, scuba diving)

Objectives and expected results

Objectives

- Assess the state of urchin populations in the MPA
- Assess the impact of professional and recreational fishing on populations
- Be able to overlay the assessment of the state of the population with a mapping of the fishing effort
- Locate areas of vulnerability
- Demonstrate the effect on populations of prohibiting or regulating fishing practices by area
- Assess the presence of poaching

Expected results

- Qualitative and / or quantitative assessments (species, abundance, test diameter, biomass) overall, by species, by population
- Quantified elements of the impact of this fishery on populations through medium to long-term monitoring
- Quantified and spatialised elements to implement appropriate management measures

Protocol description

- Before starting any counting, it is necessary to know which species are present in the area to be assessed and whether they are targeted by professional and recreational fishing. The protocols related to the evaluation of activities, effort and catches will provide some answers (see dedicated sheets).
- A count sheet must be prepared in advance. In addition to the characteristics of the dive (date, observer, site name, weather), it includes, for each replicate made, a space where the names of the species recorded and the diameter of the test of the individuals counted are noted. Plan empty lines to add any comments (urchin remains eaten on site, disease, presence of predators, etc.).
- When they are carried out through suba diving, the counts are always done in pairs. Divers should ensure that they are far enough away from each other so that they are not disturbed, while ensuring the required safety conditions at the working depth.

SAMPLING: TIME UNITS

Periodicity

At least every 3 years

Frequency

Before and after the fishing period

Duration

Between 45 and 60 minutes per count, varies according to the method chosen

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around

Monitoring subunits

- Management areas: full, partial protection, regulation of certain fishing activities
- Sub-areas determined by zoning and fishing "spots"

FEEDBACK FROM EXPERIENCE

- Medes Islands Marine Reserve (ES)
- Golf du Lion Marine Natural Park (FR)
- Côte Bleue Marine Park (FR)
- Apulia Coast (IT)

- Evaluations of sea urchin populations by diving can be done using several methods:
  - **Reference count (Sala *et al.*, 1998; Guidetti *et al.*, 2004)**
    Visual counts of sea urchins are conducted on rocky bottoms between 5 and 6 m (depth where the impact of fishing is greatest) in scuba gear. The sea urchin population is assessed at the scale of each station from random quadrats (n ≈ 20 to 30; 1 m x 1 m) or transects (n ≈ 3 to 5; between 25 m x 1 m and 50 m x 1 m divided into subtransects of 5 or 10 m²). All urchins found in quadrats or transects, with a test diameter > 1 cm, are identified by species and counted. As abundances are often very high, caliper measurements of the individuals encountered can be made on a few subtransects; at least 100 individuals measured per species should be available. Be sure to look carefully into crevices, under overhangs and boulders to properly sample all individuals.
  - **Simplified counting (Bachet *et al.*, 2016)**
    The simplified counting protocol is identical to the reference protocol in terms of station and replicate implementation. The counts are carried out twice a year, before and after each fishing season. At each site, 2 permanent transects are marked out for a simple and reproducible assessment of urchin densities. Each transect measures 25 m long x 1 m wide, for a total counting area of 50 m² per site. All individuals are identified, counted and measured using a template. The template, consisting of 2 spaced rods, allows to quickly discriminate between individuals above and below the authorised mesh. Two size classes:'>4 cm' or'<4 cm' in diameter of the test (without the quills) are taken into account. This 4 cm dimension was intentionally chosen smaller than the minimum fishing size allowed in the French Mediterranean (5 cm), so that the smaller size class (small sea urchins) really only concerns sea urchins that are not exploited or almost not exploited.
- After the counts, it is imperative to check and validate the data entered on the card: be sure to note everything (date, name of the site) and to be able to read it again.
- Biomass can be calculated with a height / weight relationship (Guidetti *et al.*, 2003).
- The data is then entered into an Excel® spreadsheet or a database. Allow time for verification of the data entry, ideally by someone other than the person who entered the data.

Implementation advice

- Sea urchins tend to aggregate. The multiplicity of the number of replicates will smooth this effect
- Be careful, sea urchins can be particularly abundant at the mouth of urban emissaries. Care should be taken to ensure that the results are properly interpreted in these particular cases
- Counts carried out in Posidonia meadows bottoms require special attention to search for sea urchins between rhizomes

Difficulties, advantages / Disadvantages

- The positioning of the study stations can be tricky (see 'Implementation advice'), do not hesitate to call on ecologists for this.

Advantages

- Relatively easy to implement
- Interesting long-term monitoring
- Monitoring of interest to professional fishers, choosing sites with them, stock that can be co-managed

Disadvantages

- Observations are difficult in posidonia beds
- Choice of sites is tricky due to the heterogeneity observed in general between sites
- Long and tedious work

Material

- Scorecard sheet
- Graduated tape (pentameter) or 1 m x 1 m quadrat
- Caliper or template
- Free diving or scuba diving equipment
- Boat and pilot

€ Estimated costs (€: low, €€: medium, €€€: high)

€	Human resources
€	Specific service for data collection, **€€** if external service for database design
€	Investment / material
€€	Data analysis, desirable partnership with scientists

Administrative procedures, legal provisions

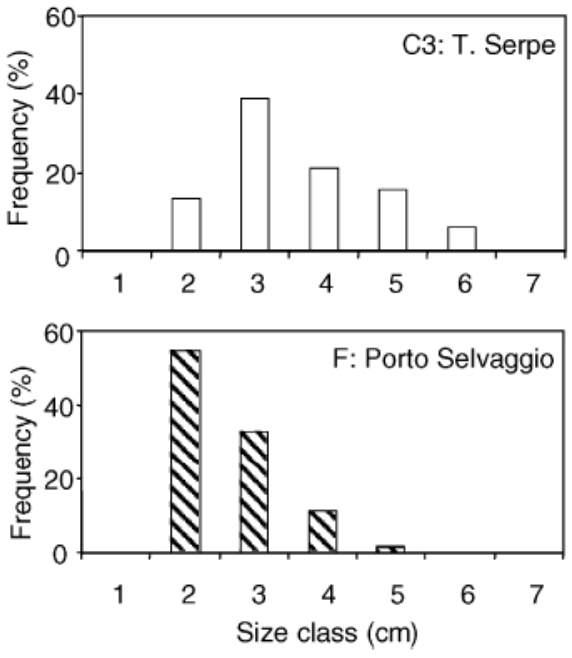
- Authorisation to access areas where diving is prohibited, if applicable

Type of results obtained / Metrics

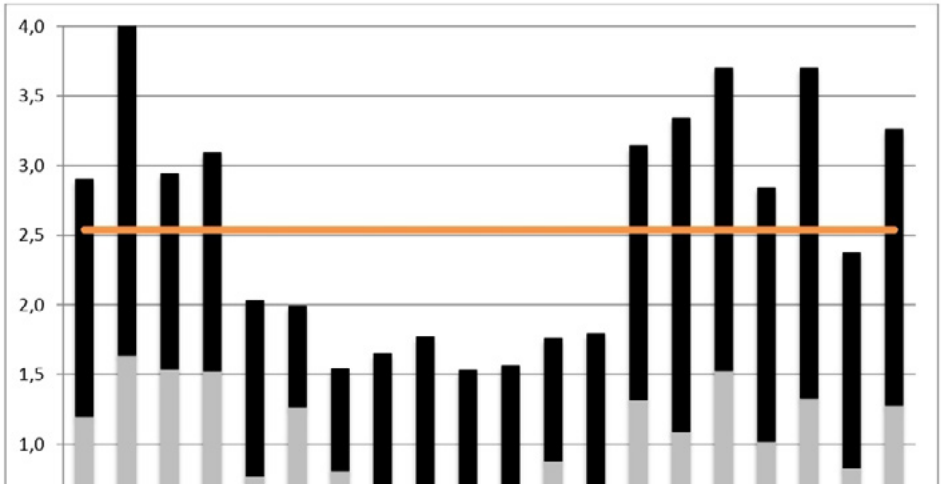
- Basic metrics:
  - species list
  - number of individuals by species
  - demography by species
- Derived metrics:
  - average specific abundance
  - average density by species
  - average biomass by species
  - proportion of individuals below and above the authorised mesh size

Graphical representations

- Tables, histogrammes of basic and derived metrics



Frequency of urchins >1 cm test size in a fished (F) and non-fished (C3) site. Size classes: 1, 0-1 cm; 2, 1-2 cm; 3, 2-3 cm; 4, 3-4 cm; 5, 4-5 cm; 6, 5-6 cm; 7, 6-7 cm (according to Guidetti et al, 2003)

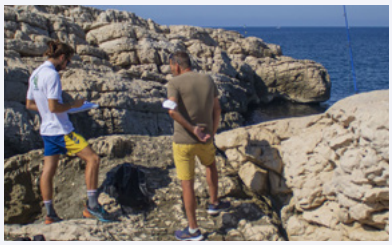


Evolution of the average density of small (petits) and large (gros) *P. lividus* individuals before and after fishing periods. Simplified protocol (Côte Bleue Marine Park)

To go further

- Bachet *et al.*, 2016. Suivi de l'évolution des populations d'oursins comestibles (*Paracentrotus lividus*) sur la Côte Bleue – Résultats des comptages d'octobre 2016. Rapport Parc Marin de la Côte Bleue et Comité Régional des Pêches Maritimes CRPMEM PACA, Fr. : 1-18.
- Charbonnel *et al.*, 2017. Suivis scientifiques du site atelier sur les peuplements de poissons et les mesures de gestion sur la Côte Bleue. Rapport de synthèse 2015-2016. Convention Parc Marin de la Côte Bleue & Agence de l'Eau RMC. Rapport Parc Marin de la Côte Bleue publ. Fr. : 1-163.
- Guidetti *et al.*, 2004. Effects of the edible sea urchin, *Paracentrotus lividus*, fishery along the Apulian rocky coast (SE Italy, Mediterranean Sea). Fisheries Research, 66: 287-297.
- Sala *et al.*, 1998. Temporal variability in abundance of the sea urchins *Paracentrotus lividus* and *Arbacia lixula* in the northwestern Mediterranean: comparison between a marine reserve and an unprotected area. Marine Ecology Progress Series, 168: 135145.

Economic impact assessment (activity related expenses) of recreational fishing from surveys (direct or indirect)



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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the approach and methodology, acceptance of users
- Study to be set up as part of a partnership agreement with federations, associations

REMARKS

The estimation of the economic impact or economic spinoffs is based on the evaluation of the costs and benefits generated by the activity according to the fishers' expenses and the value of the catches on the market. To date, this method has been the most widely used, although it has shortcomings (revenue estimated from catches, costs, well-being and pleasure of the fisher not taken into account)

ACTIVITIES CONCERNED

Shore fishing, on-board fishing, underwater fishing, fishing on foot

Objectives and expected results

Objectives

- Know the economic importance of recreational fishing and evaluate it in comparison to other maritime activities, identify the weight of market and non-market values
- Better understand the motivations and not only the aspects related to the practice (capture / pressure / impacts)
- Assess the economic effectiveness of the MPA: importance of recreational fishing in the MPA, benefits and costs associated with the MPA (attractiveness of the MPA), adaptive behaviours, restoration of ecosystem services useful to recreational fishers
- Implement management actions integrating their impacts on the activity: evaluation of the economic impact, constraints associated with certain measures, evaluation of the consequences on fishers and their 'well-being' resulting from the practice of this activity
- Analyse the evolution of practices as regards their economic impact for the MPA and their role in the economic development of the territory
- Quantify the economic importance of the activity for the MPA in order to have arguments for obtaining financial resources to better manage these leisure activities
- Economic incentive to change the behaviour and mindsets of recreational fishers

Expected results

- Identification of user groups
- For each group: identification of potential costs and benefits related to the MPA
- Quantitative assessment of these costs and benefits
- Costed elements to implement appropriate management measures

Protocol description

- In this protocol, recreational fishing is addressed by its individual practice; it is considered as a non-market activity (free or semi-free services: access to the sea, fish production). Other methods that take into account the notion of well-being exist: contingent valuation, transport costs, etc.
- The economic impact corresponds to the economic spinoffs generated on a territory. These are the expenses generated by the practice of recreational fishing activities. The total economic impact is the sum of direct, indirect and induced effects (Le Corre *et al.*, 2011):
  - **Direct effects** represent the initial and immediate effects of a specific activity, in terms of turnover, value added, employment or tax revenue. For example, the direct effects

SAMPLING: TIME UNITS

Monitoring periodicity

According to the evolution of leisure activities and tourism. Every 3, 5 or 10 years.

Duration

- On-site survey: 9 months (March to November)
- Telephone survey (excluding analyses): 1 to 2 months

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPAs and attractive areas (fishing spots) (see section 'Difficulties, advantages / Disadvantages')

FEEDBACK FROM EXPERIENCE

- MPA of Sinis and Maldiventre Island (IT)
- Columbretes Islands Marine Reserve (ES)
- Malta Fisheries Management Area (MT)
- Cerbère Banyuls National Reserve (FR)
- Côte Bleue Marine Park (FR)
- Bouches de Bonifacio National Reserve (FR)

of visitors' use of a site correspond to the gains made by companies directly related to this use (accommodation, paid visits, catering, etc.). Direct effects generate a series of incomes, primary expenditures that lead to indirect and induced effects ('snowball' effects);

- **Indirect effects** occur when companies (intermediate consumption) related to the first activity spend money on other local companies which activities are technically related to the previous ones (upstream companies);
- **Induced effects** are linked to the final expenditure of the agents benefiting from the direct and indirect effects and residing in the area. These agents contribute to the circulation of income in the local economy. However, part of the income is lost when fleeing outside the local area. The magnitude of indirect and induced impacts depends on the propensity of local businesses and households to consume locally produced goods and services (Stynes 1997).

- In the proposed protocol, the economic impact is addressed only by estimating direct effects. (Methods for assessing indirect and induced effects are more complex and evolve - get help from economists (Boncoeur *et al.*, 2013).
- Data collection can be carried out through on-site surveys, off-site surveys (telephone, mail, website), questionnaire submissions (stores, harbours, etc.) and the use of existing databases by economists.
- Information to be collected (see Alban *et al.*, 2006 and Roncin *et al.*, 2008):
  - Fisher's identifier:
    - basic information: gender, year of birth / age range, socio-professional categories, main place of residence / region / country, type of activity carried out (shore fishing, on-foot, underwater, on-board)
    - on-board and underwater fishing: share of annual boat trips during which fishing activity is carried out
  - Budget allocated to the fishing practice:
    - boat budget (owner and tenant): fixed part (port, mooring, insurance, maintenance, equipment, wintering, etc.), variable part (fuel, maintenance, rental cost if applicable)
    - material budget: fixed part (boat equipment (GPS, depth sounder, etc.), purchase of fishing gear), variable part (annual maintenance, baits, lures, clothing, etc.)
    - other expenses: trip fees (food, drinks), subscriptions to fishing magazines, memberships in associations / federations, registration for fishing competitions, fishing guides or charters
    - accommodation, food and souvenirs (if non-resident): number of nights, number of people travelling on the same budget, overall expenses over the duration of the stay (travel, nights, food), first visit to the MPA (if not, how many years ago, how many times a year, intention to return), what role did fishing play in the decision to come to the region?
  - Criteria for allocating economic benefits to the MPA:
    - location of fishing areas
    - interest and motivation of the fisher for this particular site and link with the MPA (important to define the share of activity within the MPA)
    - Personal experience of the fisher surveyed
    - fishing season: all year round, in summer, holidays
    - seniority of the fisher: how long has he been fishing?
    - frequency of practice: number of fishing days
    - the 5 factors that most influenced the choice of this site (ranking from 1 to 5 according to the importance of the criterion), example: fish abundance, regulations, experience, landscape beauty, weather conditions, proximity to the MPA, low fishing presence / other uses in the area
    - total catch per year
  - Fishing area of the day:
    - fishing habit in the fishing area of the day: usual, occasional, unusual
    - site use of this fishing area per year / season
    - proportion of annual catches from this fishing area
    - time and means of transport to get to the area
  - Influence of the MPA and link with the fishing practice:
    - knowledge of the MPA, fishing in the authorised area within the MPA, proportion of catches in the MPA
    - does the MPA influence the choice of fishing area?
    - does the MPA have an influence on fishing activity? very positive, positive, no influence, rather negative, very negative, very negative, does not know (NA)

Implementation advice

- The question of the panel's representativeness is crucial: it is important to have information on the profile of volunteer fishers. In order to ensure a good weighting, it is advisable to carry out a preliminary survey (by telephone or on site) to define the representative parent population of fishers (see corresponding sheet). The results obtained will thus be compared to the parent population. Otherwise, it is advisable to collect any type of data to better define this population from associations, the tourist office, etc.
- Distinguishing between residents and non-residents is important. These are 2 fishing populations that cannot be surveyed in the same manner (occasional / yearly presence), that will not face the same expenses (accommodation for non-residents, etc.) and that will not spend money in the same places (benefits are not necessarily local for the material expenses of a non-resident person). These particularities will have to be taken into account when extrapolating.
- Sampling of sites where fishers are interviewed may or may not be random: random selection of sites from a list of sites visited, quota-based approach based on prior classification of sites, empirical approach based on the manager's experience and knowledge of the area and habitats, etc.
- The choice of the day for the fishers' survey is made according to different criteria of variation in site use (preliminary survey, see corresponding sheet): seasonality, availability of fishers (weekend, holidays, public holidays), fishing schedules, according to the fishing habits of fishers (if they are known in advance).
- To be representative, a sample must have the same characteristics as the population. When surveying a homogeneous site in terms of fishing mode, randomness can be obtained by moving from one group of fishers to another and interviewing a person at random within each group (random question to determine the person). Except in the case of a quota-based approach, the randomness of the fishers surveyed is important.
- The results of the surveys must be used anonymously.

Difficulties, advantages / Disadvantages

- A delicate point of the off-site survey is to delimit the perimeter of the survey: how far from the site should the inhabitants be questioned? The further away from the site, the lower the site use rate and the more expensive the survey becomes to conduct. There is a trade-off between exhaustiveness and cost.

Advantages

- Protocol based on tangible data and real behaviour. It can sometimes be difficult to define what is specifically related to recreational fishing practice, hence the importance of defining allocation criteria to understand fishers' motivations (by targeting questions focused on the reasons given by the fisher to visit this particular area, for example).

Disadvantages

- Requires significant reflection and preparatory drafting to be relevant
- Complex statistical approaches
- Many aspects of the value of recreational fishing in MPAs are not taken into account (welfare, non-use value, etc.)

Material

- If at-sea investigation: boat (+ fuel), pilot and investigator, possible with a single pilot-counter observer
- Survey sheet fixed on a tablet

€ Estimated costs (€: low, €€: medium, €€€: high)

€€ Human resources (help from internship students and / or volunteers can reduce costs)

€€ Specific service for data collection otherwise 0 internally

€€ Investment / material, if a boat is needed (fuel), otherwise €

€€ Data analysis, use an economist if possible

Administrative procedures, legal provisions

- Favour unregistered and anonymous surveys. If not, ask the interviewee for permission and ensure that the legislation in force on individual freedoms is respected
- Generally speaking, the interviewees are over 15 years of age (if the person interviewed is a minor, the agreement and presence of at least one accompanying adult are required

Type of results obtained / Metrics

- Socio-economic metrics by activity:
  - distance between the place of residence and the MPA
  - number of 'first' visits
  - intention to return
  - male / female ratio
  - age of respondents by type of activity
  - socio-professional category of respondents by type of activity
  - country / city of residence by type of activity
  - distribution of residents / non-residents by type of activity
  - length of stay by type of activity
  - annual budget of the activity by type of activity
  - number of MPA visits per year, by type of activity (user loyalty)

Graphical representations

- Tables, histogrammes, pie charts of socio-economic metrics by activity

Fishing related expenses (in €/ year), estimated after surveys of recreational fishers and fishing charters (Alban *et al.*, 2007)

MPA	Mean	Standard Deviation	Answering Rate
Bonifacio	1 154	758	100%
Côte bleue	610	1 007	97%
La Graciosa	1 511	5 316	97%
Malta	1 242	2 271	91%
Monte da Guia (I)	982	1 163	98%
Monte da Guia (C)	9 866	5 420	65%
La Restinga	167	214	99%
Sinis	1 631	1 445	96%
FULL SAMPLE	1 022	3 177	96%

Source: EMPAFISH Recreational Fishing survey 2005-2006 (individual fishers and charter-fishing customers)

To go further

- Alban *et al.*, 2006. Methodological guidebook for socio-economic field surveys of MPA users. University of Western Brittany CEDEM / GdR AMURE (Brest, France). 45 p.
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Willingness to pay (WTP) assessment ('well-being' of the fisher) of recreational fishing by the transport cost method

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the approach and methodology, acceptance of the practitioners
- Inform the authorities (town hall) and local partners of the progress of the study

REMARKS

This method takes into account the well-being provided by the fisher's fishing activity. The assessment of well-being is done by estimating willingness to pay. In order to assess this well-being, contingent valuation methods, or transport costs, have been developed

ACTIVITIES CONCERNED

Shore fishing, on-board fishing, underwater fishing, walking

Objectives and expected results

Objectives

- Better understand social and economic parameters and not only practical aspects (capture / pressure / impacts)
- Know the economic importance of recreational fishing and put it in perspective with other maritime activities, identify the weight of market and non-market values
- Assess the economic efficiency of the MPA: the weight of recreational fishing in the MPA, the benefits and costs associated with the MPA (attractiveness of the MPA), adaptive behaviours, restoration of ecosystem services useful to recreational fishers
- Implement management actions by integrating their impacts on the activity: evaluation of the economic impact, constraints associated with certain measures, evaluation of the consequences on fishers and their 'well-being' resulting from the practice of this activity
- Analyse the evolution of practices in terms economic impact on the MPA and their role in the economic development of the territory
- Quantify the economic importance of the activity for the MPA in order to have arguments for obtaining financial resources, in order to better manage these leisure activities
- Economic incentive to change the behaviour and attitudes of recreational fishers

Expected results

- Willingness to pay assessment (measurement of fishers' well-being)
- Motivations and behaviours of fishers
- Evaluation of fishers' perceptions
- Costed elements to implement appropriate management measures (example: implementation of a paying fishing licence)

Protocol description

- In this protocol, recreational fishing is addressed by its individual practice as a non-market activity (free or semi-free services: access to the sea, fish production).
- The transportation cost method is used to determine the non-market value of recreational uses of natural sites. The method is based on the premise that to benefit from the recreational amenities provided by a natural site, the visitor must travel to the site and incur transportation costs. These costs are implicit prices and make it possible to estimate the recreational use value of the site (Terra, 2005). They provide a monetary assessment of the well-being of users on the site.

SAMPLING: TIME UNITS

Monitoring periodicity

Acquisition of basic data every year

Frequency

Evaluation of the WTP every 5 years, unless there is a significant change in practice

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPAs and areas of attractiveness (see section 'Difficulties, advantages / Disadvantages section)

FEEDBACK FROM EXPERIENCE

- Marine Protected Area of Sinis and Maldiventre Island (IT)
- Columbretes Islands Marine Reserve (ES)
- Malta Fisheries Management Area (MT)
- EMPAFISH and PAMPA programmes: Cerbère-Banyuls and Bouches de Bonifacio Marine Nature Reserves and Côte Bleue Marine Park (FR)

- Data collection can be carried out through on-site surveys, off-site surveys (telephone, mail, website), questionnaire submissions (stores, harbours, etc.) and the use of existing databases by economists.
- Information to be collected:
  - Fisher's identifier:
    - basic information: gender, year of birth / age range, socio-professional categories, main place of residence / region / country, type of activity carried out (shore fishing, on-foot, underwater, on-board)
  - Respondent's fishing practice:
    - type of activity practiced: shore fishing, on-foot, underwater, on-board
    - trip frequency
  - Simple transport costs (amounts spent on travel):
    - distance from home (resort if applicable) / fishing location
    - distance between port and fishing area
    - transport time
    - mileage costs
    - number of passengers
  - Criteria for assigning economic values to the MPA:
    - location of fishing areas
    - interest and motivation of the traveller and the fisher for this particular site (and link with the MPA). For more information on the criteria to be considered see Voltaire et al, (2017)

Implementation advice

- As with all sampling plans, the question of panel representativeness is paramount. It is therefore important to have information on the profile of volunteer fishers. In order to ensure a good weighting, it is strongly recommended to carry out a preliminary survey (by telephone or on site) to define the representative parent population of fishers (see corresponding sheet). The results obtained will thus be compared with the parent population.
- When studying the profiles of anglers, the distinction between residents and non-residents is important. These are 2 populations of fishers that cannot be surveyed in the same manner (occasional / yearly presence), and that will not face the same expenses. In addition, transportation costs do not always relate only to recreational fishing practices. These particularities will have to be taken into account when extrapolating.
- Sampling of sites where fishers are interviewed may or may not be random: random selection of sites from a list of sites visited, quota-based approach based on prior classification of sites, empirical approach based on the manager's experience and knowledge of the area and habitats, etc.
- The choice of day to interview fishers is made according to different criteria of variation in site use (preliminary survey, see corresponding sheet): seasonality, availability of fishers (weekend, holidays, public holidays), fishing schedules, according to fishers' fishing habits (if known in advance).
- To be representative, a sample must have the same characteristics as the population. When surveying a homogeneous site in terms of fishing mode, randomness can be obtained by moving from one group of fishers to another and interviewing a person at random within each group (random question to determine the person). Except in the case of a quota-based approach, the randomness of the fishers surveyed is important.
- The results of the interviews must be anonymised.

Difficulties, advantages / Disadvantages

- A delicate point of the "off-site" survey is to define the scope of the survey: how far from the site should the inhabitants be interviewed? The further away from the site, the lower the site use rate, the more expensive the survey becomes to conduct. There is a trade-off between exhaustiveness and cost

Advantages

- A method based on proven choices, not hypothetical choices as may be the case in other welfare valuation methods such as contingent valuations.
- Possibility of collecting basic data every year and calculating the WTP only after a few years (periodic analysis)

Disadvantages

- Complex statistical approaches
- Limited data analysis when trips are made for multiple reasons and are not entirely attributable to recreational fishing activity, or when trips are made to multiple sites at the same time. A common practice to address this difficulty is to identify the main purpose of the visit and to collect information on the characteristics of visits only for this purpose
- Sample containing no observations corresponding to zero number of visits, i.e. people who never visit the site (overestimation of values, see Terra (2005) for available statistical solutions)

Material

- If at-sea investigation: boat (+ fuel), pilot and investigator, possible with a single pilot-counter observer
- Survey sheet maintained on a tablet

€ Estimated costs (€: low, €€: medium, €€€: high)

€€€ Human resources (help from internship students and / or volunteers can reduce costs)

€€ Specific service for data collection if survey at sea from a boat, otherwise **0**

€€ Investment / material if a boat is needed (fuel), otherwise **€**

€€ Data analysis

Administrative procedures, legal provisions

- Favour unregistered and anonymous surveys. If not, ask the interviewee for permission and ensure that the legislation in force on individual freedoms is respected
- If the person interviewed is a minor, the agreement and presence of at least one accompanying adult is required

Type of results obtained / Metrics

- Socio-economic metrics by activity:
  - male / female ratio
  - age of respondents by type of activity
  - socio-professional category of respondents by type of activity
  - country / city of residence, distribution of residents / non-residents by type of activity, distance between place of residence and MPA
  - transport cost
  - experience of fishers by type of activity
  - number of MPA visits per year, by type of activity (user loyalty)
  - number of first visits, intention to return
  - fishing practices by type of activity

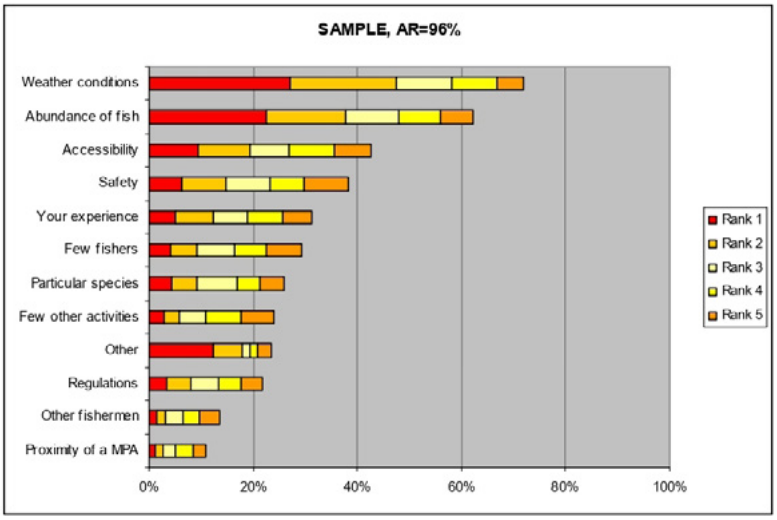
Graphical representations

- Tables, histogrammes, pie charts of socio-economic metrics by activity
- List of variables used for the models: basic data that can be acquired each year

Socio-economic variables and associated statistics used for the evaluation by the transport cost method of the value of Mont-Saint-Michel, a World Heritage site (Voltaire *et al.*, 2017) (BECO programme).

Variables	Description	Mean	Median	SD
Adult population	Total adult population of each *département*	493319.2	4 00 000	369641.4
Travel cost without OCT	Travel cost from *département* to Mont-Saint-Michel (OCT excluded) (2010 euros)	198.66	192.05	101.41
Travel cost with OCT	Travel cost from *département* to Mont-Saint-Michel (OCT included) (2010 euros)	224.37	217.43	113.68
Household income	Average annual taxable income (2010 euros)	14425.59	14087	1861.46
Unemployed	% of labour force currently unemployed	8.13	8.04	1.32
M/H_prof	% of managers and higher intellectual professions	12.14	10.37	5.52
T/A prof	% of technicians and associate professionals	24.45	23.37	2.15
Farmers	% of farmers	2.69	2.45	2.14
Craft workers	% of craft and related trades workers	6.45	6.23	1.58
Employees	% of employees	29.64	29.50	2.24
Manual workers	% of manual workers	25.62	26.01	5.08
Econ_inactive	% of the population economically inactive	28.15	28.20	2.11
Parents with children	% of parents with children	55.02	54.67	4.77
Historical monuments	Number of listed historical monuments	150	137	79.40

Ranking of the criteria for choosing a visit to the fishing site, based on socio-economic surveys ((Alban et al., 2007)



To go further

- Alban *et al.*, 2006. Methodological guidebook for socio-economic field surveys of MPA users. University of Western Brittany CEDEM / GdR AMURE (Brest, France). 45 p.
- Alban *et al.*, 2007. Marine Protected Areas Socio-Economic Data. A review of EMPAFISH field survey results. EMPAFISH program. University of Western Brittany CEDEM / GdR AMURE (Brest, France). 115 p.
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- Terra, 2005. Guide des bonnes pratiques pour la mise en œuvre de la méthode des coûts de transport. Direction des études économiques et de l'évaluation environnementale. Série Méthode 05-2005. 40 p.
- Voltaire *et al.*, 2017. Valuing cultural world heritage sites: an application of the travel cost method to Mont-Saint-Michel. Applied Economics, 49(16): 1593-1605. DOI: 10.1080/00036846.2016.1221046.

Socio-economic surveys

Economic assessment of professional fishing through surveys

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Agreement of professional fishers
- Notify local and regional representatives of the profession

REMARKS

In the socio-economic field, the objectives call for considerations of efficiency and equity by considering use and non-use values

Both market and non-market uses can be taken into account

In addition, scientific and cultural aspects remain closely linked to fishing activities

ACTIVITIES CONCERNED

Small coastal métiers: various gear (nets, longlines, traps including stationary traps), collection (sea urchins, shellfish), but also possible for trawling métiers and all commercial fishing métiers

Objectives and expected results

Objectives

- Maintain or improve food security: nutritional needs and availability of local seafood
- Maintain or improve livelihoods: economic status of coastal residents, stabilisation or diversification of professional fishers
- Maintain or improve non-monetary benefits to society: aesthetic value, value of the natural wilderness, recreational opportunities, cultural value, value of environmental services
- Distribute equitably the benefits from the MPA: monetary or non-monetary benefits between coastal communities, improvement of equity within social structures and between social groups
- Maximise compatibility between management and local culture
- Promote environmental awareness and knowledge (Pomeroy *et al., 2004*)

Expected results

- Local models for the use of marine resources
- Local values and beliefs about marine resources
- Perceptions regarding the availability of seafood, abundance of local resource harvested
- Perceptions regarding non-market values use and non-use
- Distribution of household income by source
- Household business structure
- Community infrastructure and shops, number and nature of markets
- Knowledge of natural history stakeholders, dissemination of knowledge within communities

Protocol description

- The proposed methodologies are intended to be compatible with limited resources and adaptable to local resources. Information is collected from households and key informants and groups, as well as through simple field observations.
- The protocol presented here only takes into account the use values of small-scale fisheries generated by MPA ecosystem services (EMPAFISH method, also applicable to recreational fishing). Non-use values are not addressed.
- The indicators focus on the effects of MPA uses on the local economy, and are limited to market-based effects. These indicators are exclusively "factual" (as opposed to perception indicators) and quantitative: income and employment generated locally by the

SAMPLING: TIME UNITS

Monitoring periodicity

Every 2, 3 or 5 years

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA

FEEDBACK FROM EXPERIENCE

- Côte Bleue Marine Park (FR)

uses considered. The number of variables and indicators is limited, their analysis uses perception data.

- The primary data required for the construction of the indicators are collected through field surveys conducted with samplings of professional fishers = users of the MPA services. The variables collected aim to understand the effects of MPA use on the local economy, i.e. the economy of the land area adjacent to the MPA.
- The annual site use estimate of the MPA by professional fishers is provided by the managers of the MPAs concerned (see dedicated sheet). In some cases, the estimate can be refined, verified, supplemented from other sources (e.g. surveys of other users).
- An estimate of the revenues and jobs generated locally by the use of the MPA is made. Given the absence of data at the local level, this estimate is limited to "direct" income and employment. The methodology used is based on a distinction between users who transform MPA ecosystem services into commodities (commercial fishers) and users who consume these services for recreational purposes (recreational fishers).
- The revenues and uses that are recognised correspond to the activity of commercial fishing within the MPA, taken as a proxy for the area where the 'spillover' effects generated by the no-fishing zone are significant (a fragile hypothesis but difficult to avoid in the absence of precise information on these effects). The estimation is done as follows:
  - the elements resulting from the field survey of professional fishers attending the MPA are: annual landed value, employment in fishing in full-time equivalents (FTEs), share of annual activity carried out in the MPA
  - value added, i.e. the landed value less intermediate consumption (fuel, etc.) is estimated by applying standard ratios to the landed value (70 % for vessels under 10 metres; 50 % for vessels between 12 and 24 metres). These ratios come from the literature on small-scale fishing in the French Mediterranean (Leblond *et al.*, 2008)
  - direct income and employment generated by fishing activity in the MPA are estimated by applying to the annual value added and number of FTEs of the ratio resulting from the survey representing the share of annual activity carried out in the MPA
  - the results per vessel are high at the scale of the fleet operating in the MPA using information on the site use of the area
- A similar methodology was used in the framework of the AMPHORE programme devoted to a multidisciplinary analysis of 2 French Mediterranean MPAs (Port-Cros National Park, Bouches de Bonifacio Natural Marine Reserve) and 2 West African MPAs (Mauritania, Senegal). In the case of this programme, socio-economic indicators cover not only the impacts of the MPA on fisheries and recreational uses of the ecosystem, but also, more generally, its effects on economic development and the well-being of local populations. In addition, they deal with the social and financial sustainability of the MPA. The approach considering the effects of the MPA in terms of stakeholders' perceptions is privileged.

Implementation advice

- It is important to clearly define the area adjacent to the MPA as it depends on the size and use of the MPA under consideration. The most appropriate operational translation for the term "area adjacent to the MPA" is probably the notion of employment area. All commercial fishers using the MPA are considered "local", a reasonable assumption given the home port and size of fishing vessels operating in the MPAs.
- Take into account only the part of the activity of fishers that is related to the MPA (MPA administrative perimeter). Pay attention however, to the fact that the area in which the conservation measures taken under the MPA have an impact on fisheries may not coincide with this administrative perimeter.
- The assessment of the dependence of the professional fishing activity or activities on the MPA is important.
- The method does not clearly attribute the estimated socio-economic effects to the existence and management of the MPA: if the study areas were not protected, they would probably continue to be used by fishers, whose activity and / or presence in the area would generate income and employment.

- It is difficult to separate the 'site effect' from the 'reserve effect'. Measuring the income and jobs actually generated by the uses of the services provided by the ecosystem of an MPA does not make it possible to separate them, hence the importance of using stakeholders' perceptions for better analysis.
- For fishers, the balance of advantages and disadvantages is more complex and uncertain: on the one hand, the operation reduces their area of activity, but on the other, they can hope to benefit from the 'spillover' effect that the reserve must generate. It is therefore necessary to prepare the questions well and to work on the analysis of the results concerning perception.
- The results of the surveys must be anonymised.

Difficulties, advantages / Disadvantages

Advantages

- Qualitative information on the relative importance of the reserve effect and the site effect can be obtained from responses to the survey on the perceptions and opinions of MPA users
- A comparison of the responses of small-scale fishers and diving clubs on the influence that the existence of the MPA exerts, according to them, on their activity shows a contrast between the 2 types of activity. The responses of diving centre managers are generally much more positive than those of professional fishers, for example
- Perception surveys, which are rather well received by fishers and easy to implement, help to overcome the 'psychological' difficulties raised by objective questions on income and employment

Disadvantages

- Financial resources are needed to collect the required basic data
- Complex statistical approaches
- The absence of a reference state prior to the creation of the MPA and the difficulty of establishing a control zone outside the MPA make it difficult to directly estimate the reserve effect on observed behaviour
- Perceptions only provide information on how reality is perceived by users (sincerity? accuracy?)
- It is difficult to estimate how much the income of professional fishers would vary (and in which direction) if the area were not protected

Material

- Survey sheet on paper or tablet
- Few materials required: staff to conduct surveys
- Printing paper sheets

€ Estimated costs (€: low, €€: medium, €€€: high)

€€	Human resources (help from internship students and / or volunteers can reduce costs)
€€	Specific service for data collection, sinon **0** en interne
€	Investment / material
€€	Data analysis, faire appel à des économistes si possible

Administrative procedures, legal provisions

- If surveys / interviews are recorded, ask the interviewee for permission and ensure compliance with current legislations on personal freedoms

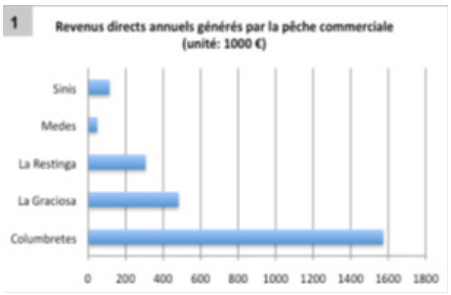
Type of results obtained / Metrics

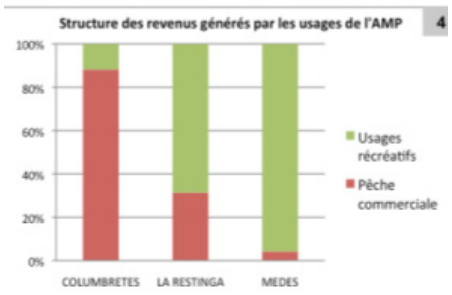
- Basic metrics by activity:
  - generated revenues
  - employment generated
  - number of fishers per commercial activity

Graphical representations

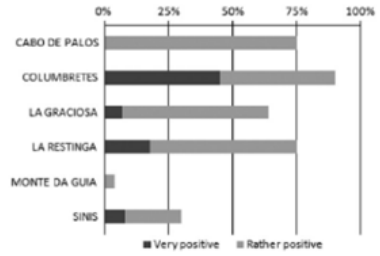
- Tables, histogrammes, pie charts of socio-economic metrics by activity
- List of variables used for the models: basic data that can be acquired each year.

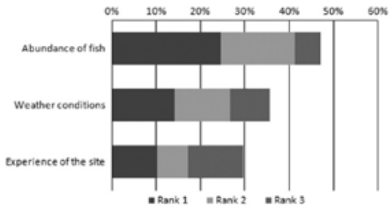
Results of an economic survey in some MPAs (Alban *et al.*, 2007)





Results of opinion surveys among professional fishers under the EMPAFISH programme (2005-2006 surveys) on the left: impact of the MPA on their commercial activity, on the right: 3 main criteria for choosing a fishing site (Roncin *et al.*, 2008)



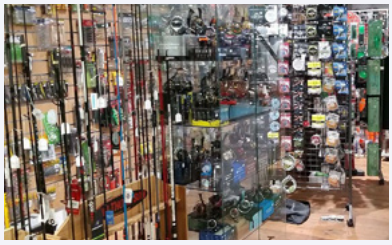


To go further

- Garcia *et al.*, 2011 Les aires marines protégées et la pêche : Biologie, Socio-économie et Gouvernance, PUP.
- Leblond *et al.*, 2008. Synthèse des flottilles de pêche 2006. SIH, Ifremer, 220 p.
- IUCN manual:
  - Pomeroy *et al.*, 2004. How is your MPA doing? A Guidebook of Natural and Social Indicators for Evaluating Marine Protected Area Management Effectiveness. Gland, Switzerland and Cambridge, UK: IUCN
- SocMon GCRMN (Global Reef Monitoring Network) methodology and adaptation for the Westeern Indian Ocean:
  - Bunce *et al.*, 2000. Socioeconomic Manual for Coral Reef Management. GCRMN, Australian Institute of Marine Science, Townsville, 264 p.
  - Malleret-King *et al.*, 2006. Guide de suivi socioéconomique pour les gestionnaires du littoral de l'océan Indien occidental (SocMonWIO). CORDIO East Africa, Mombasa, 108 p.

- EMPAFISH methodology:
  - Alban *et al.*, 2006. Methodological guidebook for Socio-Economic Field Surveys of MPA Users. Projet EMPAFISH, WP3, Deliverable 9. UBO, Brest, 38 p.
  - Alban *et al.*, 2007. Marine Protected Areas Socio-Economic Data. A review of EMPAFISH field survey results. EMPAFISH program. University of Western Brittany CEDEM / GdR AMURE (Brest, France). 115 p.
  - Roncin *et al.*, 2008. Uses of ecosystem services provided by MPAs: how much do they impact the local economy? A southern Europe perspective. Journal for Nature Conservation, 16 : 256-270.
- AMPHORE methodology:
  - Boncoeur *et al.*, 2011. Bioeconomic analysis of marine protected areas fisheries effects. In Claudet J. (Ed.) Marine Protected Areas: a Multidisciplinary Approach, Cambridge University Press: 190-225.

Assessment of the economic impact of recreational fishing based on the study of the sector



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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the approach and methodology to data providers and acceptance collection
- Study to be set up in the framework of a partnership agreement with data providers

REMARKS

The estimation of the economic impact (economic spinoffs) is apprehended here from the professional sector that exists around recreational fishing

ACTIVITIES CONCERNED

Shore fishing, on-board fishing, underwater fishing, fishing on foot

Objectives and expected results

Objectives

- Better understand the economic parameters and not only the practical aspects (capture / pressure / impacts)
- Know the economic importance of recreational fishing and compare it with other maritime activities, identify the weight of market values
- Assess the economic efficiency of the MPA: weight of recreational fishing in the MPA, benefits and costs associated with the MPA (attractiveness of the MPA), restoration of ecosystem services useful to recreational fishers
- Quantify the economic importance of the activity for the MPA in order to have arguments for obtaining financial resources to better manage these leisure activities
- Economic incentive to change the behaviour and mindsets of recreational fishers

Expected results

- Quantitative assessment of the costs and benefits of the MPA
- Costed elements to implement appropriate management measures

Protocol description

- Recreational fishing is a popular activity that is a major asset for the future of maritime activity, but which has an impact on the environment. Many recreational fishers are passionate people who spend money - equipment, boats, houses - and can also be involved in the protection of natural resources.
- The object of the study is the economic sector of recreational fishing (equipment stores, services, etc.) considered as a commercial activity. If one prefers to take into account the use values generated by MPA ecosystem services, it is better to use an EMPAFISH-type methodology, which focuses on calculating the effects of MPA uses on the local economy, limiting itself to market-based effects.
- The economic impact corresponds to the economy generated on a territory, which is understood here through the professional sector that has developed around this activity from: nautical industries, guides and organised outings, professional fishers who practice charter, places of distribution of equipment (supermarkets, specialised shops, internet), magazines dedicated to sea fishing, tourism industries, insurance, port equipment (to be weighted with the share of use of the boat for recreational fishing), etc. (non-exhaustive list).

SAMPLING: TIME UNITS

Monitoring periodicity

Every 2, 3 or 5 years depending on the development of the activity and the economic activity

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and attractivity zones, unit to be adapted according to that of the available data

- Information to be collected: turnover, quantity and quality of purchases, number of distributors, number of jobs, target audience (local, tourists), number of customers and profiles (residents/non-residents), seasonality, etc.

Implementation advice

- Exhaustiveness can be searched for on a restricted area. However, these data may be subject to statistical confidentiality.
- At a national level, it could be wise to rely on the networks and representatives of the economic sector concerned by recreational fishing or on national statistical data. At a local level, the meeting of local companies could be considered.
- Whatever the methods used to acquire the data, it is important to weight the data: according to the type of fishing practiced for example (on board or not) and according to the location of the practice (the shops visited are not necessarily on the fishing grounds).
- Interview results should be anonymised.

Difficulties, advantages / Disadvantages

- This work must be carried out by economists.
- Data processing will have to be adapted according to the structure taken into account: data cannot be analysed in the same way for a specialised store and for a store with many specialities (i.e. sports department stores).

Advantages

- Quantified economic approaches provide precise data in terms of statistics: number of people, profiles, etc.
- A different and complementary perspective than that of ecologists, sociologists or historians on the uses
- Useful arguments to defend requests for funding or positions in support of management

Disadvantages

- Complex statistical approaches
- Risk that some structures refuse to share their figures, especially at a local level
- Effect on the local economy difficult to identify because equipment purchases are not necessarily made at the place where fishing is practiced. This is all the more true since the scale at which one wishes to assess economic importance is small (a site / a city / an MPA)

Material

- Survey sheet maintained on a tablet

€ Estimated costs (€: low, €€: medium, €€€: high)

€€€	Human resources (help from internship students and / or volunteers can reduce costs)
€€	Specific service for data collection
0	Investment / material
€€	Data analysis

Administrative procedures, legal provisions

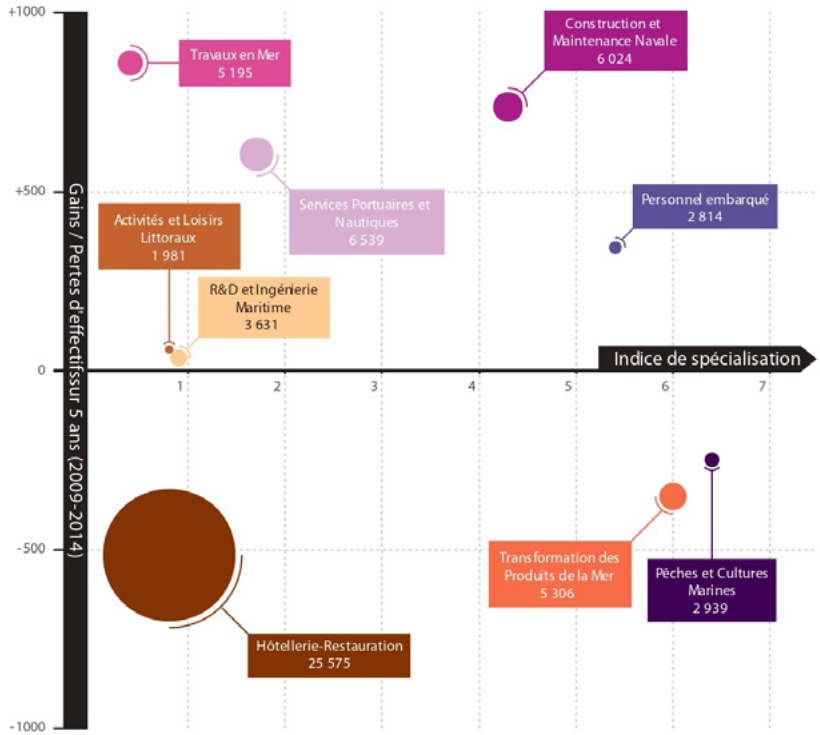
- Ensure data use and confidentiality clauses (statistical confidentiality) and obtain the necessary authorisations if necessary

Type of results obtained / Metrics

- Socio-economic metrics by professional activity:
  - annual turnover
  - number of jobs
  - number of customers
  - number of clients / season
  - costs

Graphical representations

- Tables, histogrammes, pie charts of socio-economic metrics by activity
- List of variables used for the models: basic data that can be acquired each year.



Employees in the 10 families of the sea sector (end 2014). The specialisation index reflects the specific nature of certain activities in Brittany ((French region on the Atlantic coast): the larger a point, the higher the number of employees for the sector of activity - the higher it is, the more jobs the sector has gained over 5 years (respectively: low : lost) - the more to the right, the more Brittany is specialised in the sector compared to the national one (Source ACOSS, Pôle Emploi, 2016)

To go further

- Gamp *et al.*, 2016. Pêche récréative : un guide pour vous orienter dans vos méthodes de suivis – Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des aires marines protégées, Fr. : 199 p.
- Pôle Emploi, 2016. La Filière Mer. Bilan à fin juin 2015 sur l'emploi, le marché du travail et la formation en Bretagne. Etudes et Recherches. P. Sebert, edit., Pôle Emploi Bretagne, Publ., 28 p.

Evaluation of professional fishers' perceptions (opinions) from an interview or questionnaire

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Inform about the project and consult with the known fishing network to ensure the success of the operation. Have an idea of the parent population
- Operators or owners of professional fishing boats
- Ensure the profile diversity of the people surveyed

REMARKS

- Perception (opinion) surveys provide a better understanding of professional fishers, to whom management actions are addressed. They make it possible to detect any upstream blocking points
- Perceptions and opinions differ according to individuals but also according to the groups to which they refer (even within the profession)
- The protocol presented here can be adapted to work on the historical aspects with older fishers (evolution of practices, catches). The perception survey is also useful for economic evaluations

ACTIVITIES CONCERNED

Small coastal métiers: nets, longlines, traps including stationary traps, gathering (sea urchins, shellfish)

Objectives and expected results

Objectives

- Understand the specific relationships that professional fishers have with the sea, the MPA and other users of the MPA
- Identify the factors that determine the diversity of observed behaviours: acceptance, support or rejection of certain management measures
- Define the leverage actions to be implemented to limit and remove any blockages
- Define the actions to be implemented in order to sustainably change the behaviours that are most harmful to the environment and / or other users
- Evaluate the ownership and effectiveness of the management actions implemented
- Assess the fishers' commitment to the MPA project and the effectiveness of the management actions put in place
- Better understand the relationship that fishers have locally with the sea in the territory of the MPA
- Better understand the current expectations of fishers

Expected results

- Understand how fishers perceive the state of the environment and the evolution of the resource
- Understand how they see the effects / impacts of their own practices on the environment and resource
- Know how they view the other actors in the MPA territory (other users, managers, decision-makers, associations, etc.): territories of practice, actual and / or potential conflicts, responsibilities, etc.
- Know how fishers view fishers who are still active in the MPA territory: fishing grounds, actual and / or potential conflicts, responsibilities, etc.
- Determine their knowledge of the regulations and their perception of the different management actions within the MPA: understanding, acceptance / rejection, effectiveness, legitimacy, suggestions

Protocol description

- The purpose of an interview is to understand the speeches and behaviours of professional fishers, and to research the questions they ask themselves. It is the diversity of views and arguments expressed that is sought. This is a qualitative approach.

SAMPLING: TIME UNITS

Monitoring periodicity

According to the evolution of professional fishing activities

Duration

Interview: about 1 hour

Survey questionnaire: 20-30 min maximum

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around, fishing territory

FEEDBACK FROM EXPERIENCE

- Côte Bleue Marine Park (FR)

- The investigator must not impose either his point of view or his reflection on the problem addressed.
- An interview guide must be written beforehand. It is intended to structure the interrogation but does not direct the speech. It specifies the conceptual framework (who? why? etc.), the introductory sentence of the interview, the themes and sub-themes that will be addressed during the exchanges, the strategy that the investigator will have to adopt (directive, semi-directive, non-directive) and the social characteristics of individuals (sociological profile).
- Interviews can be conducted according to:
  - A **directive technique**: the investigator asks questions corresponding to the problem of the investigation without proposing any element of response. Respondents respond freely and can speak at length if they wish. It is therefore not a questionnaire.This technique still guides the respondents' discourse because they must fit within the framework defined by the questions. It has the advantage of collecting accurate information on certain topics but, on the other hand, does not allow a thorough exploration of all the respondent's thoughts (respondents may not feel totally free to express all their ideas, thoughts, feelings).
  - A **non-directive technique**: the interviewer does not ask questions, but only listens to the respondent after asking her / him to express herself / himself on a given topic. He intervenes only to help her / him express themselves and takes care not to direct their remarks (he expresses neither approval nor disapproval, adopts an empathic attitude). This technique promotes free speech during the interview in which the unsaid is able to express itself. It allows the respondent to express his or her ideas in depth. This collects a wide range of ideas and opinions expressed by the public. This technique allows the interviewer to perceive the emotions and thought patterns that appear in the respondent's comments.
  - A **semi-directive technique**: a combination of the 2 previous techniques, where the interviewer directs the respondent to certain subjects and then allows him / her to express him/herself freely. If some topics are not spontaneously addressed, the investigator may invite the person to comment on them.
- Perception surveys can be conducted among professional fishers (see sheet "Evaluation of perceptions of recreational fishers based on a questionnaire") and are based on a prepared and detailed questionnaire that proposes specific response methods but may also include spaces for expression in the form of free observations noted by the investigator.
- If interviews are not conducted with all professional fishers working in the MPA territory, then the sample of interviews will be considered satisfactory when the new interviews no longer reveal new points of view (diminishing yield method).
- Specify on each maintenance support or questionnaire which fleet the surveyed vessel belongs to.
- The interview / investigation can take place at the port or at a place and time convenient for the fisher (facilitates trust and free speech). The return of a fishing trip is not necessarily the best time (fatigue after being at sea, priority to selling or packaging the fish).
- The topics covered can be varied:
  - the social and economic characteristics of the respondent (age, fisher / fishing manager / seaman, etc.) and the fisher's experience
  - the activities carried out on the territory of the MPA and their evolution (type of métier, frequency, locations, equipment and techniques used, fishing experience in the MPA, etc.)
  - perceptions of the evolution of the state of the environment, the resource (diversity of catches, height / weight, number, new species, etc.)
  - perceptions about governance, consultation, decision-making
  - perceptions on regulation, zoning of the MPA
  - the expectations formulated
  - the solutions to be proposed

Implementation advice

- A socio-historical analysis (conflicts, alliances, positioning during the creation of the MPA, significant events) prior to any perception / opinion study is recommended. Taking into account the "experience", history and various significant events influences people's representations and perceptions at a given time.
- Any recent event, especially if it has been covered by the media, must be taken into account. It alone can strongly influence the results of the perception survey (postpone the survey?)
- The investigator must not impose either his point of view or his reflection on the problem addressed. Several intervention strategies of the investigator can be used to deepen the information obtained: contradiction, instruction or external question, follow-up or paraphrase.
- An interview can be conducted collectively and each person then expresses herself / himself. In this case, the group should be small (a few individuals) and heterogeneous (so that there are differences of opinion among participants) but not too large (to avoid blockages). It should be noted that there is a dependence of the comments on the exchanges that are created between the participants. The results obtained will not be the same as in a personal interview.
- It is useful to select the people to be interviewed beforehand according to a previously defined typology (young fisher, experienced fisher, group leader, type of jobs practiced, etc.). This provides as much diversity of perspective as possible.
- In the absence of experience with specialist interviewing or support methods, favour the perception survey based on a questionnaire with proposed framed answers (see perception survey for recreational fishing).
- The perception survey can be a module of the socio-economic survey. A series of preliminary questions to define the typology of the activity is strongly recommended.
- As with other data acquisitions, it is advisable to organise a restitution to fishers, at least to those who have participated or better to all of them because they will show up next time or will not fail to say that the sampling is insufficient or will provide additional information on this occasion (incentive to participate).

Difficulties, advantages / Disadvantages

Advantages

- Interview:
  - allows you to go into detail about the ideas and perceptions of the interviewees
  - provides accurate and detailed answers
  - the time spent can establish a relationship of exchange, trust with talkative fishers or annoy a hurried person: find a good compromise.
- Survey with questionnaires:
  - long to develop, but quick collection time in the field
  - requires interviewing as many fishers as possible in each category.

Disadvantages

- Interview:
  - long collection time
  - analysis and synthesis of long and tedious data. Beware of misinterpretations. It is advisable to use human science experts (anthropologist, sociologist, geographer, historian)
  - the practice of interviews requires special skills and know-how. If the manager has not been trained in these methods, he or she should seek the assistance of qualified individuals when writing the interview guide

Material

- Interview outline maintained on a tablet
- Dictaphone, if applicable (but may impress the respondent), for recording and correct transcription of the interview
- Video recording if applicable (but may impress the respondent)

€ Estimated costs (€: low, €€: medium, €€€: high)

€€€ Human resources (help from internship students and / or volunteers can reduce costs)

€ Specific service for data collection if necessary external support , otherwise **0**

0 Investment / material

€€€ Data analysis

Administrative procedures, legal provisions

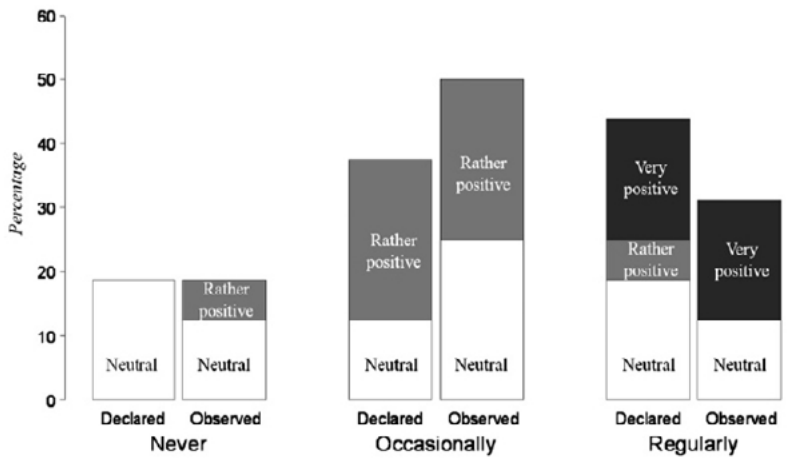
- In the case of recorded interviews, ask the interviewee for permission and ensure compliance with the legislation in force related to individual freedoms.

Type of results obtained / Metrics

- Opinion metrics: perception of the MPA and fishing strategies
- Basic metrics by activity, ship owner / non-owner :
  - knowledge of the existence of the MPA
  - advice on the level of information on the MPA
  - knowledge of fisheries regulations, MPA
  - advice on relevance, regulatory compliance
  - opinion on the involvement of fishers in the decision-making process
  - advice on the effect of the MPA on their fishing methods
  - advice on the effect of the MPA on their fishing effort
  - users' perception of conflicts of use

Graphical representations

- Tables, histogrammes, pie charts of perception metrics by activity



Perception of professional fishers on the effects of no-take zones on their activity as a function of their frequency of fishing in the adjacent zone (never=never, occasionally=occasionally, regularly=regularly) (Leleu *et al.*, 2012)

To go further

- Alban *et al.*, 2006. Methodological guidebook for socio-economic field surveys of MPA users. Projet EMPAFISH, WP3, Deliverable 9. University of Western Brittany CEDEM / GdR AMURE (Brest, France), 45 p.
- Himes *et al.*, 2003. Small scale Sicilian Fisheries: opinions of artisanal fishers and sociocultural effects in two MPA case studies.
- Leleu *et al.*, 2012. Fishers' perceptions as indicators of the performance of Marine Protected Areas (MPAs). Marine Policy, 36(2), 414-422. Publisher's official version: http://doi.org/10.1016/j.marpol.2011.06.002, Open Access version: http://archimer.ifremer.fr/doc/00060/17137/

Question module to characterise the activity of professional fishers and their perception in relation to MPAs (Alban *et al.*, 2006; EMPAFISH Programme).

EMPAFISH Questionnaire on Professional Fishing

(Information about individuals will remain strictly confidential)

1. Date: _____
2. MPA Name: _____ **2bis: Fleet category:** _____

INFORMATION ABOUT YOUR FISHING ACTIVITY

3. Name and registration number of your vessel: _____
4. Registration port: _____
5. Where do you live? **Town:** _____ **County / Region:** _____

6. Are you: ☐ Owner of your vessel ☐ Co-owner ☐ Not the owner
7. How many boats do you own? _____ boats
8. Year of birth: _____
9. Date you started fishing: _____
10. Size of the household: _____ people

11. What are the main technical features of your vessel(s)?

Boat number	Length (metres)	Tonnage (GT)	Engine power (kW)	Annual number of engine operating hours	Year of construction	Year of purchase	Usual crew size (including skipper)	**If chartering**, Max. no. of authorized passengers (not including crew)
1								
2								
3								

12. According to your estimation, what is the present second hand market-value of your boat and fishing gears? _____ €

13. Average distance between harbour and main fishing grounds (nautical miles)

When fishing inside the MPA	When fishing outside of the MPA
_____NM	_____ NM

14. What are the 5 major factors influencing your choice of fishing site? Please rank these features from the most important (1) to the least important (5).

	Please rank
Abundance of fish	
Weather conditions	
Presence of particular species	
Regulations	
Your experience	
Accessibility / proximity of the fishing area	
To go fishing where other fishermen already fish	
Proximity of a marine protected area	
Few fishers go fishing in this area	
Few other activities on this area (diving, surfing, sailing…)	
Other (please specify:)	

15. Details of your fishing activity

	Overall description	Description by gear		
		Gear 1	Gear 2	Gear 3
Gear name				
Main targeted species				
Name of species 1				
Name of species 2				
Name of species 3				
Annual number of trips				
Total number (trips/year)	Trips	trips	trips	trips
% in the MPA	%	%	%	%
Average trip duration (hours / trip)				
When fishing inside MPA	Hours	hours	hours	hours
When fishing outside MPA	Hours	hours	hours	hours

YOUR PERCEPTION OF MPAS AND YOUR FISHING STRATEGIES:

27. For how many years have you been fishing in the MPA ? _____

28. On the whole, what is the impact of the MPA on your fishing activity?
☐ Very positive ☐ Rather positive ☐ No impact ☐ Rather negative ☐ Very negative

29. What do you think of the following statements

	Fully agree	Rather agree	Rather disagree	Fully disagree	Don't know
The MPA helps to protect biodiversity					
The MPA enhances fish abundance inside the area					
The MPA enhances fish abundance outside the area					
The MPA helps to attract tourists					
The MPA benefits mainly professional fishing					
The MPA benefits mainly recreational fishing					
The MPA benefits mainly scuba-diving					
The zoning system of the MPA helps to reduce conflicts among different types of users					
The MPA helps to reduce illegal fishing					
The MPA is good for the local economy					

30. How are relations with other users?

	Good cooperation	Conflict	No contact
Recreational fishing charters			
Other professional fishermen			
Independent recreational fishermen			
Spear fishers			
Divers			
Jet ski users			
Surfers, windsurfers, kite-surfers…			
Other users (*please specify :*)			

31. How has your fishing effort changed since the creation of the protected area?
☐ It increased
☐ It remained unchanged
☐ It decreased

31a. If your fishing effort has decreased, do you now spend that time:
☐ On other activities related to fishing (mending fishing gears, commercialisation…)
☐ On non-fishing activities

32. Has the creation of the protected area influenced the way you fish?
☐ Yes
☐ No

32a. If Yes, how?
☐ You are targeting other species
☐ You are no longer fishing in the area of the MPA
☐ You are fishing close to the boundaries of the MPA
☐ You are using other fishing gears
☐ Other (please specify: .....)

33. Do you have any comments about our questionnaire and survey?

Evaluation of recreational fishers perceptions (opinions) from a questionnaire

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

Have a large network for distributing the questionnaire and / or contact fishers directly to make the operation a success. Notify local recreational fishing associations and possibly federations.

REMARKS

- Perception (opinion) surveys provide a better understanding of recreational fishers, to whom management actions are addressed. They make it possible to detect any blocking points upstream
- Perceptions and opinions differ according to individuals but also according to the groups to which they belong
- The protocol presented here can be adapted to work on historical aspects with older fishers (evolution of practices, catches)

ACTIVITIES CONCERNED

Shore, on foot, gathering, underwater, on-board fishing, individual fisher except those on board with fishing charter

Objectives and expected results

Objectives

- Understand the specific relationships that recreational fishers have locally with the sea, the MPA and other users
- Identify the factors that determine the diversity of behaviours observed: the process of land appropriation, support or rejection of certain management measures
- Define the leverage actions to be implemented 1/ to limit difficulties, remove possible blockages or conflicts; 2/ to permanently modify the most damaging behaviours to the environment and / or other users
- Evaluate the ownership and effectiveness of the management actions implemented

Expected results

- Understand how recreational fishers perceive the state of the environment and the evolution of the resource
- Understand how they see the effects / impacts of their own practices on the environment and resource
- Know how other actors in the MPA territory (other users, managers, decision-makers, associations, etc.) are viewed, what is their territory of practice, actual and / or potential conflicts of use, etc.
- Knowledge of the regulations and the different management actions within the MPA: understanding, acceptance / rejection, effective measures, perception of the legitimacy of certain regulations, suggestions

Protocol description

- A questionnaire survey is used to identify the different perceptions and opinions of recreational fishers about the MPA. The representativeness of the interviewees is important. This is a quantitative approach.
- The questionnaire consists in a series of questions designed to relate the practices and their determinants. The work required to formulate and draft the questions is important and should not be neglected. During this phase, it is necessary to:
  - list the information to be collected
  - define how the questionnaire is to be administered
  - choose the format and content of the questions (MCQ, open-ended answers, etc.) These choices must be made taking into account the problems of the study and statistical processing.

SAMPLING: TIME UNITS

Frequency

When the MPA is set up or when the management plan is drafted, then updated every 5-10 years to take any changes in perception into account

Duration

Less than 15 min

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and adjacent areas, fishing spots in or near the MPA (see section on Difficulties, advantages / Disadvantages)

FEEDBACK FROM EXPERIENCE

- Sinis and Maldiventre Island Protected Marine Area (IT)
- Columbretes Islands Marine Reserve (ES)
- Malta Fisheries Management Area (MT)
- Cerbère Banyuls Natural Marine Reserve (FR)
- Bouches de Bonifacio Nature Reserve (FR)
- Côte Bleue Marine Park (FR)

- The number of people to be surveyed depends on the subject of the survey (few or many topics covered), the type of survey (exploratory, main), human and financial resources.
- The investigation may take place either during the fishing activity at the place of practice (to be avoided for underwater hunters) or outside the practice of the activity. The place can also be chosen by the respondent if he / she expresses the need for it (facilitates the relationship of trust).
- The answers depend in part on the form and order of the questions. These recommendations can help limit biais:
  - include a "no opinion" and / or "don't know" option
  - establish a balance between positive and negative choice, avoid a neutral central choice, which does not make it possible to determine whether the response is rather positive or rather negative
  - pay attention to the vocabulary and tone of the words used (avoid key words, polemics, strong connotations)
  - allow multiple responses, prioritising them to facilitate data processing
  - ensure that the wording of the questions does not guide the respondent's response and choice
  - ask a key question in different ways to ensure that they get a precise answer (cross-referencing of information)
  - start with simple and general questions before moving on to complex and more personal questions.
- There are no generic questionnaires and each questionnaire must be written according to the objectives of the monitoring, the manager, his means, the available data and the characteristics of the site. Here are some important points to collect:
  - Fisher's identifier:
    - gender, year of birth / age range, socio-professional categories, main place of residence (country, region, municipality)
    - type of activity, experience, seniority (years).
  - Knowledge of the MPA
    - are you aware of the existence of the MPA? (yes, no)
    - if so, did the existence of the MPA reserves play a role in your decision to come fishing here? (decisive, moderate, weak, nil)
  - Opinion on the regulations
    - are you familiar with the regulations of the MPA? (quote)
    - do you feel you are sufficiently informed about the regulations in force in the MPA? (yes, no)
    - do you think these regulations are well adapted? (too strict, well adapted, insufficient, don't know)
    - do you think these regulations are well respected? (yes, no, don't know)
    - did you know that there are minimum catch sizes? (yes, no).
  - Perception of the environment
    - evolution of the natural environment
    - evolution of the resource, diversity of catches, height / weight, number
    - evolution of fishing yields.
  - Perception of the MPA (its effects)
    - in your opinion, what is the role of the MPA? (open-ended or multiple-choice question with hierarchy)
    - according to you, what is the impact of the MPA on the environment? (very positive, rather positive, neutral, rather negative, very negative, don't know)
    - in your opinion, what is the impact of the MPA on the local economy in terms of employment, tourism, etc.? (very positive, somewhat positive, neutral, somewhat negative, very negative, very negative, don't know)
    - in your opinion, what is the impact of the MPA on your own fishing activity (very positive, rather positive, neutral, rather negative, very negative, don't know)
    - do you feel sufficiently involved in the decision-making process of the MPA? (yes very well, rather well, not very well, no, don't know).
  - Opinion on the relations between users (identification of possible conflicts of use)
    - what are your relationships with other users: professional fishers, other recreational fishers, scuba divers, boaters, light sailing activities, etc.? (good, conflictual, non-existent, don't know).

Implementation advice

- A socio-historical analysis (conflicts, alliances, positioning during the creation of the MPA, significant events) prior to any perceptions / opinions study is recommended. Taking into account the "experience", history and various significant events influences people's representations and perceptions at a given time.
- Any recent event, especially if it has been covered by the media, must be taken into account and can, in itself, strongly influence the results of the perception survey (postpone monitoring?)
- If the phenomenon being studied is not well known, it is advisable to start by conducting a series of open-ended interviews to identify fishers' thinking patterns and define relevant questions.
- The perception survey is a module of the socio-economic survey; it can be completed by a questionnaire on the budget dedicated to fishing, or the duration and budget of tourists' stay for economists, a questionnaire on catches that will also be of interest to ecologists. It is also a complement to the questions concerning the typology of fishing activities.

Difficulties, advantages / Disadvantages

- A delicate point of the method is to define the scope of the study: how far from the site should the inhabitants be interviewed? The further away from the site, the lower the site use rate and the more expensive the survey becomes to conduct. There is a trade-off between exhaustiveness and cost.

Advantages

- Allows a large number of people to be interviewed in a limited time
- No rewording of answers is necessary for closed-ended or multiple-choice questions. Allows you to work with multiple investigators (train them well at the beginning and monitor their work)
- Easy and relatively fast data analysis
- Possibilities to leave some questions open

Disadvantages

- A questionnaire is more simplistic than an interview
- Requires significant preparatory drafting work to be relevant

Material

- Sheet with survey questionnaire

€ Estimated costs (€: low, €€: medium, €€€: high)

€€	Human resources (help from internship students and / or volunteers can reduce costs)
€	Specific service for data collection, if necessary external support, otherwise **0**
0	Investment / material
€€	Data analysis

Administrative procedures, legal provisions

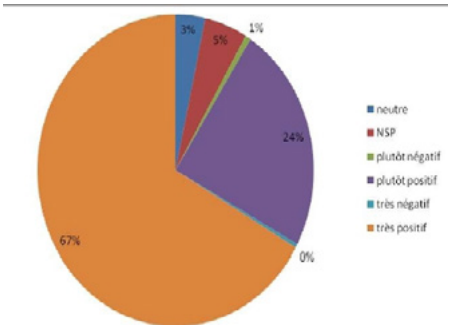
- If the fisher's full contact details are requested, the data must remain confidential and comply with the legislation in force related to individual freedom.
- If the person interviewed is a minor, the agreement and presence of at least one accompanying adult is required. Population of fishers interviewed generally: age group > 15 years old.

Type of results obtained / Metrics

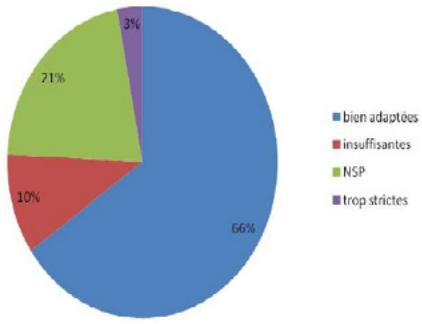
- Basic metrics by activity or resident / non-resident:
  - knowledge of the existence of the MPA, fisheries regulations, MPA
  - advice on the level of information on the MPA
- Opinion metrics:
  - advice on relevance, regulatory compliance
  - opinion on their involvement in the decision-making process
  - advice on the effect of the MPA on the ecosystem, on the local economy, on their activity
  - users' perception of conflicts of use

Graphical representations

- Tables, histogrammes, pie charts of perception metrics by activity



Opinion (in %) of the effects of the MPA on the fishing activity of recreational fishers, according to survey



Opinion (in %) of recreational fishers on the adequacy of regulations

To go further

- Alban *et al.*, 2006. Methodological guidebook for socio-economic field surveys of MPA users. University of Western Brittany CEDEM / GdR AMURE (Brest, France). 45 p.
- Alban *et al.*, 2007. Marine Protected Areas Socio-Economic Data. A review of EMPAFISH field survey results. EMPAFISH program. University of Western Brittany CEDEM / GdR AMURE (Brest, France). 115 p.
- Gamp *et al.*, 2016. Pêche récréative : un guide pour vous orienter dans vos méthodes de suivis – Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des aires marines protégées, Fr. : 199 p.
- Le Corre *et al.*, 2011. Dispositifs de suivi de la fréquentation des espaces marins, littoraux et insulaires et de ses retombées socioéconomiques : état de l'art. Rapport Géomer LETG, UMR 6554 et UMR M101 Amure, Université de Bretagne Occidentale, Agence des Aires Marines Protégées, 150 p.
- Roncin *et al.*, 2008. Uses of Ecosystem services provided by MPAs: How much do they impact the local economy? A Southern Europe perspective, Journal for Nature Conservation : 256-270.

Evaluation of recreational fishers perceptions (opinions) from an interview

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

Ensure the diversity of the profiles of the people surveyed

REMARKS

- Perception surveys (opinion) make it possible to better know recreational fishers, to whom management actions are addressed and possibly to convey awareness messages. They make it possible to detect any blocking points upstream
- Perceptions and opinions differ according to individuals but also according to the groups to which they belong
- The protocol presented here can be adapted to work on the historical aspects with older fishers (evolution of practices, catches)

ACTIVITIES CONCERNED

Shore fishing, on foot, underwater, on board

Objectives and expected results

Objectives

- Understand the specific relationships that recreational fishers have with the sea, the MPA and other users
- Identify the factors that determine the diversity of behaviours observed: the process of land appropriation, support or rejection of certain management measures
- Define the leverage actions to be implemented 1/ to limit difficulties, remove possible blockages or conflicts; 2/ to permanently modify the behaviours that are most harmful to the environment and / or to other users
- Evaluate the ownership and effectiveness of the management actions implemented

Expected results

- Understand how recreational fishers perceive the state of the environment and the evolution of the resource
- Understand how they see the effects / impacts of their own practices on the environment and resource
- Know how other actors in the MPA territory (other users, managers, decision-makers, associations, etc.) are viewed, what is their territory of practice, actual and / or potential conflicts of use, etc.
- Knowledge of the regulations and the different management actions within the MPA: understanding, acceptance / rejection, measures considered effective, perception of the legitimacy of certain regulations, suggestions

Protocol description

- An interview has the objective to understand the discourses and behaviours of recreational fishers, and seeks out the questions of the actors themselves. It is the diversity of views and arguments expressed that is sought. This is a qualitative approach (Gamp *et al.*, 2016).
- The investigator must not impose either his point of view or his reflection on the problem addressed.
- An interview guide must be written beforehand. It is intended to structure the interrogation but does not direct the speech. It specifies the conceptual framework (who? why? etc.), the inaugural instruction (introductory sentence of the interview), the themes and sub-themes that will be addressed during the exchanges, the strategy that the investigator will have to adopt (directional, semi-directive, non-directive) and the sociological profile (social characteristics of individuals).

SAMPLING: TIME UNITS

Frequency

When the MPA is set up or when the management plan is drafted, then updated every 5-10 years to take into account any changes in perception

Duration

1 h maximum

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and attractiveness areas (see section 'Difficulties, advantages / Disadvantages')

FEEDBACK FROM EXPERIENCE

- La Réunion island, Indian ocean (FR)

- The interview can be conducted according to:
  - **A directive technique:** the investigator asks questions corresponding to the problem of the investigation without proposing any response methods. Respondents respond freely and can speak at length if they wish. It is therefore not a questionnaire.
    This technique still guides the respondents' discourse because they must fit within the framework defined by the questions. It has the advantage of collecting precise information on certain subjects but, on the other hand, does not allow a thorough exploration of all the respondent's thoughts (he may not feel totally free to express all his ideas, thoughts, feelings.
  - **A non-directive technique:** the interviewer does not ask questions, but only listens to the respondent after asking him or her to express himself or herself on a given topic. He intervenes only to help him express himself and takes care not to direct his remarks (expresses neither approval nor improbation, adopts an empathic attitude).
    This technique promotes free speech, thanks to which the unsaid is able to express itself. It allows the respondent to express his or her ideas in depth. In this way, a wide range of ideas and feelings expressed by the population can be collected.
    This technique allows the interviewer to perceive the emotions and thought patterns that appear in the respondent's comments.
    This technique is sometimes used beforehand to prepare or complete questionnaire surveys (see corresponding sheet).
  - **A semi-directive technique:** a combination of the 2 previous techniques, where the interviewer directs the respondent to certain subjects and then allows him / her to express him/herself freely. If some topics are not spontaneously addressed, the investigator may invite the person to comment on them.
    This technique is sometimes used upstream to prepare or complete questionnaire surveys (see corresponding sheet).
- The sample of interviews can be considered satisfactory when the new interviews no longer reveal new points of view (diminishing returns method).
- The investigation may take place either during the fishing activity at the place of practice (to be avoided for underwater hunters and all activities in the water) or outside the practice of the activity. The place can also be chosen by the respondent if he / she expresses the need for it (facilitates the relationship of trust).
- The topics covered can be varied:
  - the respondent's social and economic characteristics
  - the activities carried out on the territory of the MPA (type of activity, frequency, locations, tools and techniques used, etc.)
  - perceptions of the evolution of the state of the environment, the resource (species diversity, height / weight, number, benthic habitats)
  - perceptions about governance, consultation, decision-making
  - perceptions on regulation, zoning of the MPA
  - the expectations formulated
  - the solutions to be proposed.

Implementation advice

- A socio-historical analysis (conflicts, alliances, positioning during the creation of the MPA, significant events) prior to any perceptions / opinions study is recommended. Taking into account the "experience", history and various significant events influences people's representations and perceptions at a given time.
- Any recent event, especially if it has been covered by the media, must be taken into account and can, in itself, strongly influence the results of the perception survey.
- The investigator must not impose either his point of view or his reflection on the problem addressed. Several intervention strategies of the investigator can be used to deepen the information obtained: contradiction, instruction or external question, follow-up or paraphrase.
- An interview can be conducted collectively, each person can then express himself. In this case, the group should be small (a few individuals) and heterogeneous (so that there are differences of opinion among participants) but not too large (to avoid blockages).

Please note: the discussion can be biaised by the exchanges taking place between the participants. The results obtained will not be the same as in a personal interview.

- It is useful to select the people to be interviewed beforehand according to a previously defined typology (individual fisher, federation manager, type of activities carried out, etc.). This provides as much diversity of perspective as possible.
- The perception assessment is a module of the socio-economic survey; it can be completed by a questionnaire on the budget dedicated to fishing, or the duration and budget of tourists' stay for economists, a questionnaire on catches that will also be of interest to ecologists. It is also a complement to the questions concerning the typology of fishing activities.

Difficulties, advantages / Disadvantages

- A delicate point of the method is to define the scope of the study: how far from the site should the inhabitants be interviewed? The further away from the site, the lower the site use rate and the more expensive the survey becomes to conduct. There is a trade-off between exhaustiveness and cost.

Advantages

- Allows you to go into the details of the ideas, feelings of the interviewees
- Provides precise and fine answers
- The time spent establishes a relationship based on exchange and trust

Disadvantages

- Long collection time
- Long and tedious data analysis. Beware of misinterpretations. Possibly call on experts (anthropologist, sociologist, geographer, historian)
- Requires special skills and know-how. If the manager has not been trained in these methods, it is recommended to be accompanied by competent persons during the construction of the survey

Material

- Outline of the interview

€ Estimated costs (€: low, €€: medium, €€€: high)

€€ Human resources (help from internship students and / or volunteers can reduce costs)

€ Specific service for data collection, if outside help needed, otherwise **0**

0 Investment / material

€€€ Data analysis

Administrative procedures, legal provisions

- If interviews are recorded, ask the interviewee for permission and ensure compliance with the legislation in force relating to individual freedoms.
- If the fisher's full contact details are requested, the data must remain confidential and comply with the legislation in force relating to individual freedoms.
- If the person interviewed is a minor, the agreement and presence of at least one accompanying adult is required.

Type of results obtained / Metrics

- Basic metrics by activity or resident / non-resident:
  - knowledge of the existence of the MPA
  - advice on the level of information on the MPA
  - knowledge of fisheries regulations, MPA.
- Opinion metrics:
  - advice on relevance, regulatory compliance
  - opinion on their involvement in the decision-making process
  - advice on the effect of the MPA on the ecosystem, on the local economy
  - opinion on the effect of the MPA on their activity
  - users' perception of conflicts of use.

To go further

- Blanchet *et al.*, 2005. L'enquête et ses méthodes : l'entretien. Paris. Edition Armand Colin. 2ème édition. 128 p.
- Gamp *et al.*, 2016. Pêche récréative : Un guide pour vous orienter dans vos méthodes de suivis Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des aires marines protégées, Fr., 199 p.
- Savarese, 2006. Méthodes des sciences sociales, Paris. Ellipse edit. 186 p.
- Thomassin A., 2011. "Des réserves sous réserve" : acceptation sociale des Aires Marines Protégées : l'exemple de la région sud-ouest de l'océan Indien. Thèse de doctorat, Université de la Réunion, 400 p.

Documentary and statistical research

Data collection and storage useful for historical investigation

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

Access to local, regional, press and personal archives. Explain the project and return the products. Cite the sources

REMARKS

Transdisciplinary approach

Access to media (paper and digital) and local and regional archives significantly contributes to the acquisition of information. Internet is useful but not sufficient !

ACTIVITIES CONCERNED

All of them

Objectives and expected results

Objectives

- Collect, date and archive all information related to professional and recreational fisheries in the MPA region
- Be aware of what is available in regional and national museums
- Identify and archive fishing information for experts: historians, ethnologists, sociologists who can analyse it as part of their work (put in the historical context)
- Know the history of fishers and their practices on the territory of the MPA, understand the natural history and the evolution of resources

Expected results

- Trace the history of uses and customs, fishing grounds, catches (e.g. knowledge of the disappearance or arrival of species on the territory of the MPA)
- Understand the evolution of fishing practices
- Understand the factors that determine the diversity of practices and behaviours observed: history of the territory, significant events
- Analyse the resilience capacities of communities in the face of natural or anthropogenic pressure
- Identify relationships or postures inherited from the past
- Better understand the expectations of fishers.

Protocol description

- The data to be collected or consulted useful for the historical survey are of several types (great heterogeneity of media):
  - **artist paintings, postcards, photos and old films** of fishers, ports, fishing scenes, species caught, sale, transport or packaging of seafood products. Put them in a document holder. Note the location of the exhibition, the name of the artist, the name and date / period of the painting, as well as the location where it was painted, the location and date of the scene, if possible.
  - **gear, fishing equipment, photos, films or notebooks** of fishers and recreational fishing federations (loan / donation) that refer to fishing techniques, catches made, fishing grounds (mapping of ancient landmarks) but also to environmental conditions
  - **newspaper articles** in local gazettes and regional or national newspapers and **any dated publication** (story, advertisement, announcement, local holiday, menu)
  - **interviews with retired fishers** dedicated to sharing past practices and catches (see interview sheet), reports of these interviews or recordings.

SAMPLING: TIME UNITS

Frequency

As days go by, as articles are passed , as testimonies are met

This frequency can be daily or episodic in connection with events that bring up information on fishing (stranding of a large mammal or fish, exhibition, commemorative festival, etc.)

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and area of influence, region in which the MPA is located

FEEDBACK FROM EXPERIENCE

- Golfe du Lion Natural Marine Park (FR),
- Environmental service of the Toulon-Provence-Méditerranée metropolis (FR)
- Site of the Salins (FR)

- This work can be carried out as an investigative mission with testimonies, evidence, etc. Do not hesitate to activate networks of volunteers (participatory sciences) or motivated students, trainees to collect data, consult the newspapers of the regional daily press for example.
- Photos or films can be taken regularly to memorize port landscapes, the part of the port reserved for professional fishers, their boats and fishing gear, fish crates, sales scenes, etc. or the return from fishing of recreational fishers, big game fishers etc.. Even if these photos are contemporary, they nevertheless constitute a memory that may be useful in several years / decades. Each photo must be referenced, dated and archived.
- Regardless of the collection period (daily or occasionally), all documents related to fishing are 1/ identified if they do not belong to the MPA, 2/ gathered in the same MPA location, digitised or cut out in the daily newspaper and archived in a binder, box, library, room, mentioning the name of the source (publication, newspaper) and the date of publication of the article and if all else fails, the collection date of the document. It is strongly recommended to scan all documents.
- This type of source can also be used in the form of scientific articles or in humanities and social science journals. Historical marine ecology has been developing since the 2000s, driven in particular by the need to better understand the state of the environment and marine populations before or at the beginning of their exploitation by humans. In particular, these approaches are used to reconstruct baseline states to better define sustainable levels of exploitation of living marine resources (McClenachan, 2009, 2012 ; Pauly, 1995 ; Saenz Arroyo *et al.*, 2005 ; Van Houten, 2013). They are also used for the management and evolution of regulations.

Implementation advice

- It is not about replacing the historian but about keeping in mind the idea of "telling the story", of finding or keeping the memory of what concerns fishing. Without dedicating a lot of time to collection, cutting the item up and putting it in the dedicated box or scanning it into the dedicated folder of an MPA computer takes a few minutes. It is possible to regularly offer an internship or regular work placement for a volunteer to classify the documents collected over a period of time.
- The use of documents may require the agreement of owners or information sources (photos, interviews). In all cases, quote them and, whenever possible, inform them of the uses made of them (exhibition invitation, copies of photos, films, articles, books, etc.).
- The digitisation of documents makes it possible to ensure a double backup: on paper and digital media. Digital files must be clearly referenced and ordered. Paper archives remain equally secure to keep, provided they are collected and restricted and, at a minimum, classified by resource date or acquisition date. The binder is preferred to the notebook (good for the inventory but not for the chronological classification). Create a unique number (key) to ensure the mandatory link between the resource object and the archive file.
- A database can be created to manage the storage of these information carriers. In the absence of a database, a spreadsheet (Excel®) can usefully list the available documents. The time initially devoted to the development of a document referencing system will then be largely made up for in order to easily access the information. A simple notebook can at least list the resources.
- Mandatory fields to describe an information resource: 1/ **identity of the document**, a unique identifier (key) that allows to find the resource, acquisition date, description of the type of document or object, date of the resource, price, origin (categories: purchase, donation, exchange), 2/ **use** keywords, use; 3/ l**ocal conservation data**: storage, place of storage

Difficulties, advantages / Disadvantages

Advantages

- Provides an opportunity to learn about the history of the site, people and the resource and to better understand the context of fishing and its evolution
- Prepares the work of experts in the human and technical sciences: historians, ethnologists, sociologists
- Can constitute a useful documentary basis for the production of an article, exhibition, animation or book within the MPA or in collaboration with experts

Disadvantages

- A daily press review can take time
- Consultation of national or regional archives, which pre-supposes knowledge of the protocols for processing the sources encountered, and mastery of their inventories, can only be effectively undertaken by archive professionals (historians, documentalists)

Material

- Camera, video camera, tape recorder, dictaphone
- Copier, scanner
- Archiving space (library, dedicated room)
- Computer for digital backup and database

€ Estimated costs (€: low, €€: medium, €€€: high)

€	Human resources (help from internship students and / or volunteers can reduce costs)
€	Call for volunteers or interns or specific service for data collection,if a database is created, otherwise **0**
€	Material purchase and survey costs according to the scope of the research
€€	Data analysis for the service of a historian

Administrative procedures, legal provisions

- Access to the archives of prud'homies / confradias or their equivalent, museums and libraries and certain documentary collections may require administrative procedures.
- Paintings exhibited in museums can generally be photographed, but it is sometimes necessary to obtain the prior consent of the museum or exhibition curator.

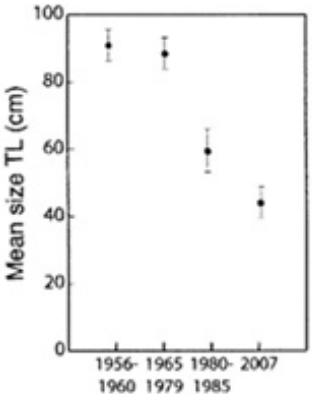
Type of results obtained / Metrics

- Basic metrics:
  - presence / absence of mentions or number of articles in newspapers concerning fishing, a species
  - number of appearances of a species in a selection of 18th century paintings
  - representation of fish, crustaceans, molluscs, jellyfish by society.
- Derived metrics:
  - number and type of boats
  - types of fishing practiced, gear used
  - list of species fished, marketed
  - evolution of the number of articles in the press
  - evolution curve and confidence interval of the size of the mentioned catches.

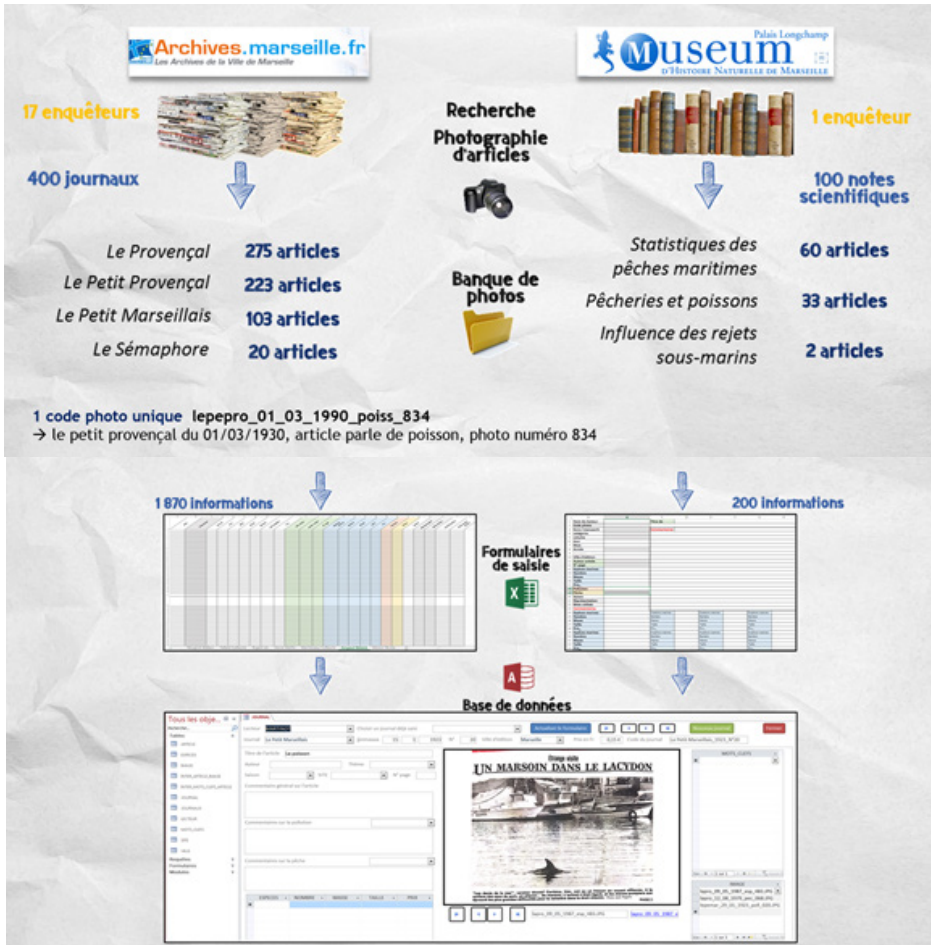
Graphical representations

- Photo albums, films, paintings
- Histogrammes

Edouard Manet (1832-1883), Still life oysters, eel and mullet. The species painted in the early painting are numbered and identified by ichthyologists (see Lapaquellerie et al., 2018).



Evolution of the average length of catches of 'trophy fish' from recreational fishing from archival photographs (McClenachan, 2009)



Methodology used for an interdisciplinary project to identify anthropogenic impacts and marine biodiversity in the Marseille region through the study of press articles during the period 1944-2001 and before 1944 (date of creation of the newspaper La Provence) for other newspapers and old manuscripts (Ourgaud *et al.*, 2018)

To go further

- Engelhard *et al.*, 2015. ICES meets marine historical ecology: placing the history of fish and fisheries in current policy context. ICES Journal of Marine Science, 73(5) : 1386-1403.
- Lapaquellerie *et al.*, 2018. Biodiversité aquatique dans la peinture moderne (XVIe-XVIIIe s.) signification écologique et dimension historique. Poster Colloque 'DD en Trans', Aix Marseille Université.
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- Saenz Arroyo *et al.*, 2005. Rapidly shifting environmental baselines among fishers in the Gulf of California. Proceedings of the Royal Society B., 272 : 1957-1962.
- SMQ, 2015. Comment documenter vos collections ? Guide de documentation du Réseau Info-Musée. Guides électroniques. https://www.musees.qc.ca/fr/professionnel/guidesel/doccoll/fr/accueil.htm
- SSIM, 2008. Elaborer une politique de gestion des collections. Guide pratique. Québec, Ministère de la Culture, des Communications et de la Condition féminine. https://www.mcccf.gouv.qc.ca
- Van Houtan *et al.*, 2013. Seafood menus reflect long-term ocean change. Frontiers in Ecology and the Environment 11: 289–290.
- Van der Starre *et al.*, 1999. Consortium for the Computer Interchange of Museum Information (CIMI). Guide to Best Practice: Dublin Core, 104 p.

Interview with retired fishers: old practices, memory of catches and knowledge of the environment

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

Inform about the project and consult with the known fishing network to ensure the success of the operation. Contact retired fishers known and recognized for their skills and memory of past events and practices

REMARKS

Perceptions and opinions differ according to individuals but also according to the groups to which they belong. Seek a diversity among interviewees: their origin, their professions or activities, their skills. Ask respondents for the names of the people they think are most relevant to interview.

ACTIVITIES CONCERNED

All of them

Objectives and expected results

Objectives

- Collect, share and maintain fishers' empirical knowledge of the species, the environment and how to exploit resources
- Retrace the history of uses, practices (gear used, periods, fishing grounds), catches
- Better understand the relationship that fishers have locally with the sea in the territory of the MPA
- Determine the factors that determine the diversity of observed behaviour: the origin of fishers, the process of land appropriation, acceptance of the MPA, acceptance or rejection of management measures
- Understand where certain situations or, sometimes, blockages come from, define the actions to be taken to change them
- Define the actions to be implemented in order to sustainably change the behaviours that are most harmful to the environment and / or other users
- Synthesize information on species life traits and functional areas within the MPA territory

Expected results

- Understand the evolution of fishing techniques and practices and events that have marked local fishing history as the arrival of fishers and new practices, new species
- Outline the exploitation of target species, if possible (Damalas *et al.*, 2015)
- Understand how fishers perceive the changing state of the environment and resource and how they perceive the impact of their own practices
- Know how fishers view their past activities: practices, fishing grounds, evolution of catches, etc. and write history
- Adapt management measures to the knowledge of species life cycle (e.g. biological rest)

Protocol description

- The interview must be prepared in order to structure the interview without directing the speech. This guide specifies: the conceptual framework (who? why? etc.), the introductory sentence of the interview, the themes and sub-themes that will be dealt with during the exchanges, the strategy that the interviewer will have to adopt (directional, semi-directive, non-directive see sheet "perception evaluation") and the sociological profile of individuals.

SAMPLING: TIME UNITS

Monitoring periodicity

Depends on the testimonies collected and studies carried out

Duration

Count 1 to 2 hours per interview

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and area of influence, region in which the MPA is located

FEEDBACK FROM EXPERIENCE

- Golfe du Lion Marine Natural Park (FR)
- Côte Bleue Marine Park (FR)

- Formulating and drafting the questions is an important task and should not be neglected. During this preparatory phase, it is necessary to:
  - list the information to be collected
  - define how the questionnaire is to be administered
  - choose the format and content of the questions (MCQ, open-ended answers, etc.).
- This choice must be made by clearly defining the objective of the interview (study issue) and thinking about the analysis (written synthesis, statistical analysis) of future responses.
- The recommended protocol is more in the form of an interview than a closed questionnaire. During the recollection, memories appear and photos and documents can then be produced by the interviewee.
- The interview framework consists of a series of questions aimed at tracing the history of people, practices, catches, territory, and all the elements that can be decisive. This protocol is similar to the one used in the historical survey (see dedicated sheet).
- If the interview focuses more on the life traits of MPA species, marine maps (photocopies in A3 format) are provided during the interview so that the fisher can directly trace the areas essential to the life cycle of marine species: gathering areas, reproduction, nursery, migration, for example (see sheet dedicated to functional zone for fisheries).
- During the interview, targeted questions may supplement information about a particular practice or species (Sáenz-Arroyo *et al.*, 2005) or critical habitats (Bergmann *et al.*, 2004).

Implementation advice

- This work requires time, listening and availability on the part of the investigator. If the investigator is not the manager, preparatory meetings are necessary to properly define the objectives of this work and it may be a little unfortunate that the manager does not collect this information directly. It is advisable to set up a mixed manager / external investigator team or to exchange a lot.
- The work will be easier if the fisher's interviewers are familiar with the fishery
- It is advisable to conduct interviews with 2 people for the MPA, which allows duplicate notes to be taken and as much information as possible to be collected.
- It is advisable to conduct interviews with only one fisher at a time to collect as much information as possible and to be able to cross-check. Nevertheless, interview techniques do exist to interview a group of subjects (see sheet 'Evaluation of perceptions (opinions) of professional fishers based on an interview or questionnaire')
- The interview can be recorded in its entirety (dictaphone, tape recorder), so that all the explanations given by the fisher are recorded. The audio document also has a testimonial value.
- The interview can also be filmed using a video camera and the filmed document will also be used as a direct testimony.
- The information provided by fishers can go well beyond the territory of the MPA. Provide regional nautical charts.
- Based on fishers' drawings, the life cycle can be reconstructed on standard species sheets, summarising information on: lifestyle, reproductive traits (age, size at sexual maturity) and height / weight / longevity, for example.
- It is important to note down whether the areas are described for the life traits of the species or for practices: fishing areas for some species, for example, are current or correspond to an elapsed period.
- Data may be inaccurate: based on memory, they can be embellished or modified. Note down the comments that seem less safe, the areas of imprecision. Cross-referencing different interviews can confirm the information collected.
- It should be borne in mind that opportunities to question in detail / at length the memory of elders are rare and may not represent themselves. This work must therefore be carefully prepared and the acquisition of data well done and properly archived (photo, sound, video documents etc.).

- The approach must be open and benevolent. Without inquisitive remarks, launch the subjects, let the interviewee speak as much as possible, bring him back into the subject being discussed if he moves too far away.

Difficulties, advantages / Disadvantages

Advantages

- Collection of information on target species but also on other marine species (elasmobranchs, marine mammals, turtles)
- Collection of indirect information on the behaviour and life traits of species resulting from fishing strategies or the use of certain gear
- Time spent and interest in fishing creates a link with the fishing community
- Training experience for the management team if they are not already familiar with the fishery
- Interviews include a part of perception assessment

Disadvantages

- Talking about the past can lead to very long stories that stray away from the subject defined beforehand
- The wording of the questions must be clever and not offend the other party
- Data may be too inaccurate, memories fuzzy (selective memory, minimising or exaggerating)

Material

- Tape recorder, dictaphone
- Camera
- Copier, scanner
- Computer for digital backup

€ Estimated costs (€: low, €€: medium, €€€: high)

€ Human resources (help from internship students and / or volunteers can reduce costs)

€ Specific service for data collection if a database is created, otherwise **0**

€ Investment / material

€€ Data analysis if expert service (fisher, ecologist, historian, geographer, etc.

Administrative procedures, legal provisions

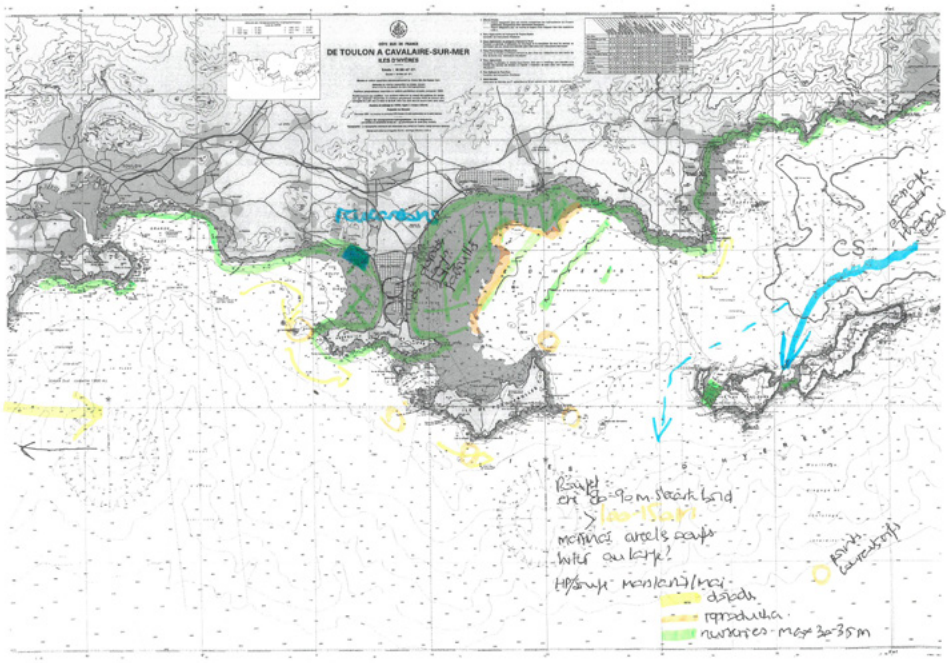
- Ensure compliance with the legislation in force related to individual freedoms.

Type of results obtained / Metrics

- Maps
- Basic metrics :
  - number of interviews conducted
  - number of years of practice of the fishers interviewed
- Derived metrics :
  - list of gear / practices that are no longer used
  - target species that have disappeared or recently appeared.

Graphical representations

- Tables, histogrammes
- Maps

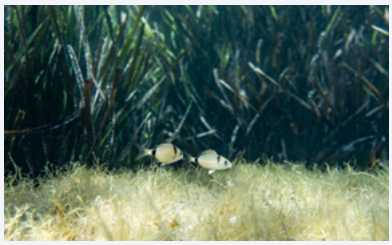


Reconstruction with the fisher of the life cycle of the main species of halieutic interest in Port-Cros National Park. The passage areas of the gilthead seabream (*Sparus aurata*) are in yellow, and those of large pelagics in blue, the breeding areas are in green © GIS Posidonia; see Charbonnel *et al.*, 2017).

To go further

- Bergmann *et al.*, 2004. Using knowledge from fishers and fisheries scientists to identify possible groundfish 'Essential Fish Habitats'. Fisheries Research, 66: 373-379.
- Charbonnel *et al.*, 2017. Suivis scientifiques du site atelier sur les peuplements de poissons et les mesures de gestion sur la Côte Bleue. Rapport de synthèse 2015-2016. Convention Parc Marin de la Côte Bleue & Agence de l'Eau RMC. Rapport Parc Marin de la Côte Bleue publ. Fr. : 1-163.
- Sáenz-Arroyo *et al.*, 2005. Rapidly shifting environmental baselines among fishers in the Gulf of California. Proceedings of the Royal Society B., 272:1957-1962.

Collection of data useful for knowledge of functional zones for fisheries, environmental watch



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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

Have a mapping of marine habitats, or at least a marine map

REMARKS

This research work can be carried out in collaboration with universities and research institutes

ACTIVITIES CONCERNED

All of them

Objectives and expected results

Objectives

- Collect, date and archive all information relating to species of fishing interest and functional zone for fisheries
- Archive information for experts: fishers, ecologists who can analyse it as part of their work
- Share and use fishers' empirical knowledge for management

Expected results

- Identification and location of functional zone for fisheries
- Have knowledge elements for the co-management of fishing areas
- Implementation of management measures to ensure their preservation

Protocol description

- Some definitions and concepts (Delage *et al.*, 2016):
  - **species of fishing interest** are understood here as biotic elements of the aquatic ecosystem of interest for commercial fishing exploitation
  - a **functional zone for fisheries** is defined as an area at sea within which at least one phase of the life cycle of a fishery resource takes place
  - the different phases of the **life cycle** are: birth and larval life, growth (separated into juvenile and adult growth) and feeding phases, the reproductive process and migration between these successive stages.

    There are different categories of functional zone for fisheries necessary for the proper development of a fishery resource (Delage *et al.*, 2016)

	When	Why	Necessary conditions	Consequence of the disturbances on the area
Spawning area	From fertilisation to hatching	Embryonic development	Adequate physico-chemical conditions	Drop in recruitment
Larval dispersal area	From hatching to final metamorphosis	Development and growth	Trophic resources. Adequate physico-chemical conditions	Drop in recruitment
Nursery area	From the last metamorphosis to the first maturation	Growth	Suitable physico-chemical conditions and habitat type. Trophic resources	Drop in recruitment
Breeding area (spawning ground)	From maturation to gamete emission	Breeding	Adequate physico-chemical conditions. Presence of congeners	Decreased reproductive efficiency
Adult growth area	From gamete emission to subsequent maturation	Growth	Adequate physico-chemical conditions. Trophic resources	Biomass decrease
Migration area	Path between 2 functional areas	Change of environment	Continuity	Break in connectivity

SAMPLING: TIME UNITS

Frequency

Along with the testimonies collected and the studies carried out.

Duration

Count 1 to 2 hours per interview

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and area of influence, region in which the MPA is located

FEEDBACK FROM EXPERIENCE

- Côte Bleue Marine Park (FR)
- Calanques National Park (FR)

The different life cycle phases must be understood for the species to be studied and the contribution of each habitat to the renewal of a population.

- Knowledge of functional zone for fisheries is part of the research work that must be carried out by scientists. Nevertheless, knowledge and observations made by users at sea throughout the year can be collected and enrich knowledge and management. Ask respondents to indicate the names of other people with knowledge ('snowball' method).
- Data can be collected through several means:
  - **interviews with fishers** (see corresponding fact sheets; Bergmann *et al.*, 2004) on their knowledge of spawning grounds, adult growth and migration (very often they do not know the areas of larval dispersal and nursery, which are not interesting for their activity): which species? where? at which time of year?
  - **interviews with divers**, who, during their diving, may witness breeding behaviour, for example, or observe species that are unusual for the area (watch). In addition to their testimonies, they may have photos and / or videos that support their statements and may become documents of scientific interest.
  - **analysis of fishers' catches** (see corresponding sheets) and observations of individuals caught (which can be noted by the fisher): presence of females with eggs (e. g. scorpion fish drool, lobster with eggs, pregnant shark). This involves listing where the data is and what it contains (date, place, method used, metrics measured): metadata catalogue
  - **evaluation of fish populations** (see corresponding sheet): the size structure of the individuals surveyed provides information on the presence of juveniles and therefore nursery areas; observations of courtship encountered during the counts provide information on the presence of spawning grounds. Similarly, it is here about listing where the data is and what it contains (date, place, method used, metrics measured): metadata catalogue.
- During the interviews, do not forget to address the temporal aspects: a spawning ground may have disappeared over time or may have moved.
- All the information collected is recorded in a file or notebook. The name and contact information of the interviewee are noted, as well as his or her age or indicators of fishing experience, and the date and location of the interview.

Implementation advice

- It is not about replacing scientists (fishers, ecologists) but about keeping in mind the idea of collecting all useful information, of keeping a record of the observations made and the testimonies collected.
- A mapping of marine biocenoses is a good support to use during interviews. The interviewee can indicate the functional zones he or she has identified with crosses, circles, arrows.
- A database can be created to manage and list all information media. In the absence of a database, a spreadsheet (Excel®) can usefully list the available documents. The time initially devoted to the development of a document referencing system will then be largely made up for in order to easily access the information. A simple notebook can at least list the resources.
- Mandatory fields to describe an information resource: 1/ **identity of the document**, a unique identifier (key) that allows to find the resource, date of acquisition, description of the type of document, methods used, metrics measured, 2/ **use** of keywords, use; 3/ **local conservation data**: storage, place of storage, possible restriction of the use of the data.

Difficulties, advantages / Disadvantages

Advantages

- Makes it possible to better understand the territory and the ecological context of species, fishing and its evolution

- Prepares the work of experts in fisheries and ecology
- Contributes to environmental monitoring (changes in species behaviour, appearance or disappearance of species)
- This work can provide a useful documentary basis for the production of an article, exhibition, animation or book within the MPA or in collaboration with experts.

Disadvantages

- Data may be difficult to obtain from fishers because it is often their fishing territory.

Material

- Tape recorder, dictaphone
- Camera
- Copier, scanner
- Computer for digital backup

€ Estimated costs (€: low, €€: medium, €€€: high)

€	Human resources (help from internship students and / or volunteers can reduce costs)
€	Specific service for data collection if a database is created, otherwise **0**
€	Investment / material
€€	Data analysis, for the service of a fisher and / or an ecologist

Administrative procedures, legal provisions

- Some data may be subject to restrictions on use or requests for authorisation (e.g. fishing logbook in the framework of a charter).

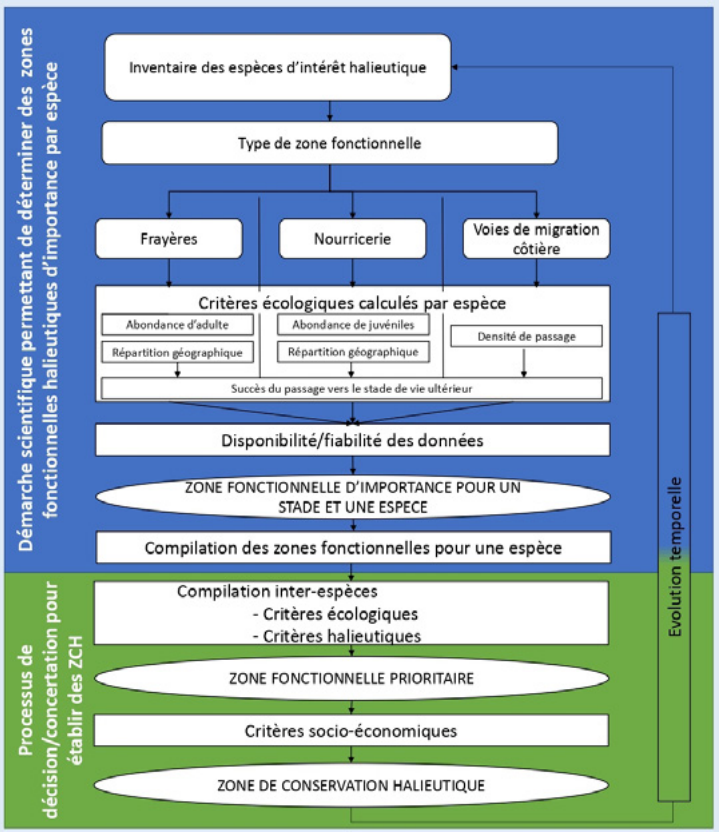
Type of results obtained / Metrics

- Basic metrics :
  - number of interviews conducted with fishers and divers
  - number of scientific studies
- Derived metrics :
  - list of species for which information is available
  - categories of functional zones for which information is available
  - surface of the functional zone for fisheries in ha, m^2 or distance of the functional zone for fisheries from the regulation or prohibition of fishing zones.

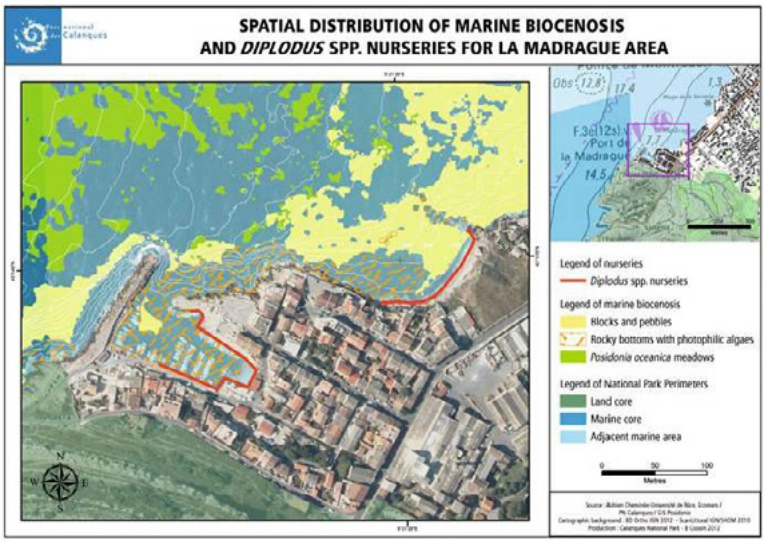
Graphical representations

- Maps of the location of functional zone for fisheries
- Photos / videos of animal behaviour
- Tables, histogrammes

Proposed approach to define important functional fisheries areas by species and then compile them to identify priority areas, in order to establish fisheries conservation zones (after Delage *et al.*, 2016)



Map of the localisation of nurseries of *Diplodus spp.* in Calanques National Park (Cheminée *et al.*, 2014).

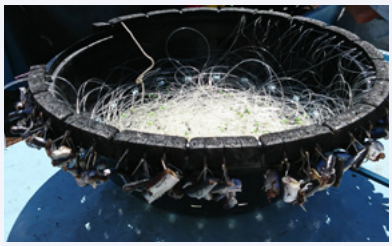


To go further

- Bergmann *et al.*, 2004. Using knowledge from fishers and fisheries scientists to identify possible groundfish 'Essential Fish Habitats'. Fisheries Research, 66: 373-379.
- Cheminée *et al.*, 2011. Assessment of *Diplodus* spp. (Sparidae) nursery grounds along the rocky shore of Marseilles (France, NW Mediterranean. Scientia Marina, 75(1) 181-188
- Cheminée A., Feunteun E., Clerici S., Cousin B., Francour P., 2014. Management of infralittoral habitats: towards a seascape scale approach. Underwater Seascapes: from Geographical to Ecological Perspectives. O. Musard *et al.* edits: 161-183.
- Delage *et al.*, 2016. Inventaire des zones fonctionnelles pour les ressources halieutiques dans les eaux sous souveraineté française. Première partie : définitions critères d'importance et méthode pour déterminer des zones d'importance à protéger en priorité. [Rapport de recherche] Pôle halieutique Agrocampus Ouest. 36 p.
- Valavanis (edit.), 2008. Essential Fish Habitat Mapping in the Mediterranean. Hydrobiologia, 612.

Catch declaration, fishing logs, user initiatives

Assessment of catches and related professional fishing effort from fishing logbooks informed by fishers



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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the approach and tool, acceptance of professionals
- Tool to be implemented within the framework of a charter or when a relationship of trust is already established
- Annual feedback of results to fishers

REMARKS

A preliminary study of the characterisation of the parent population of professional fishers is recommended to ensure a good representativeness and a better interpretation of the results collected in the logbook

The combination of fishing effort and catch information on the same medium allows for an optimisation of data collection and information entry for the fisher. The format of the logbook must also be practical for transport on board the ship

ACTIVITIES CONCERNED

Small coastal métiers: nets, longlines, traps including stationary traps, collection (including coral, sponge, holothurian)

Objectives and expected results

Objectives

- Assess the use of the MPA by professional fishers, fishing effort and catches
- Know the métiers practiced, the categories of fishing gear used and their density in the MPA, the species targeted / sought after and caught according to the type of gear and the season
- Know the spatial (maps) and temporal distribution of these sampling activities on the site (days, months, seasons, years)
- Know the spatial (maps) and temporal distribution of catches made (CPUE) by métier, by gear category, taken from the site (days, seasons, years)
- Be able to superimpose this distribution with a habitat mapping
- Locate areas of vulnerability
- Better manage uses as part of a management plan, reduce conflicts
- Demonstrate the effect on populations of prohibiting or regulating fishing practices by area
- Assess the means to be put in place to carry out awareness-raising actions
- Supplement, where appropriate, the data acquired by other protocols (landing surveys, boarding of observers, counting from the coast, aerial counts, etc.).

Expected results

- Quantitative assessments (number of vessels, fishers, gear) of the professional fishing effort
- Qualitative and / or quantitative assessments (species, number, biomass) of catches made by fishers: total catch and main target species
- Evaluation of métiers and practices in the MPA
- Evaluation of CPUE from reported catches
- Quantified and spatialised elements to implement appropriate management measures

Protocol description

- The MPA provides the fisher with a fishing logbook that he can / should fill in on each trip. Ideally, the logbook should be filled in just after the trip in order to avoid errors.
- In order to simplify entries, the logbook is composed of daily logs on which the fisher is asked to describe precisely the different information related to his fishing day in the MPA or including part of his fishing operations in the MPA. The entries in the logbook and daily

SAMPLING: TIME UNITS

Monitoring periodicity

The protocol can be reproduced annually

Frequency

The logbook must be completed at each fishing trip in the MPA

Duration

A few minutes, depending on the fishing effort and the catches made during the trip

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA or share of catches in the MPA in relation to the total catch in the fishing area (the latter is to be determined)

Monitoring subunits

Categories of management areas (areas where one or more fishing activities are regulated), specific site

FEEDBACK FROM EXPERIENCE

- Port-Cros National Park (FR)

trip forms must remain easy and quick for the fisher. It is better to focus on entering the logs for each trip rather than on the exhaustiveness of the information collected (e.g. overall catches by gear category trammel net, gillnet, longline, for example and not by gear)

- The fishing logbook can be in paper format or digital format online on the Internet. The choice of format will have to be made in agreement with the fishers so that it can be adapted (make sure that the tool is well understood)
- The fishing logbook can be distributed to volunteer fishers recruited following a preliminary survey, for example (see corresponding sheet). The keeping of a logbook may also be mandatory in the framework of a charter or specific conditions of access to a fishing area
- Information to be collected by fishing logbooks:
  - Information on the site and the day's conditions:
    - date, duration of the trip, location (name of the fishing site, zoning map based on visual cues easily identifiable in the field: cape, port, islet, etc.).
  - Practices (to be adapted for fishing red coral, sponges and holothurians):
    - type and number of fishing gear used, gear characteristics (mesh size, length), setting times, setting depth.
  - Catches made (to be adapted for fishing red coral, sponges and holothurians):
    - for each gear category (if the scoring format allows): name of species caught, number, height / weight (or provide small / medium / big grids), discards (name species, specify reason)
    - if no capture, indicate it.
  - Additional information:
    - other users met
    - invasive species, pollution (fishers' watch)
    - a space is left for free comments.
- The recovery of the files by the MPA can be done in different ways:
  - automatically on a database of the investigating body if the logbook is online
  - following regular visits to the port (periodicity to be defined) by the interviewer in order to collect data from the past period. This type of data collection makes it possible to maintain regular exchanges with fishers.
  - delivery to the investigating body (mail, hand-delivery) on a periodicity to be defined (semi-annual, annual). A new fishing logbook is then issued in exchange.
- The results obtained jointly must be presented to fishers in a spirit of co-management and to motivate their participation in data collection. This can be done through automated analyses (type of fishing carried out per trip, on site, etc.) in the case of an online fishing logbook or during an annual feedback meeting organised by the MPA with professional fishers

Implementation advice

- Comprehensiveness is possible in MPAs where there are few professional fishers. Otherwise, the representativeness of the fishers' panel is essential. It is therefore important to have information on the profile of volunteer fishers. It is advisable to carry out a preliminary survey (possible by telephone but preferable on site) to define the representative parent population of fishers (see corresponding sheet) and put the results into perspective.
- In the case of an obligation to keep a fishing logbook (special regulation or charter), the parent population = the sampled population.
- Ensure that certain categories of fishers are not under-represented because they are difficult to contact (e.g. occasional fishers on site).
- Encourage fishers to complete each log completely, to not forget any trip and to provide information at regular meetings (e.g. annual meeting dedicated to fishing in the MPA and charter renewal - if relevant)
- Ensure that all fishing operations in the MPA are recorded in the logbook even if they are only part of the day's operations or if there was no catches, so as not to underestimate the total annual catch in the MPA or the average daily catch in the MPA.

- The manager and any associated scientists must guarantee the confidentiality of the data (anonymity, data aggregation, global restitution).
- In the entry forms (database), provide multiple choice boxes or drop-down menus to limit errors (see disadvantages).
- The fishing logbook is a tool for fishers and managers alike. It is the ultimate co-management tool that provides information specifically related to the MPA and makes it possible to assess the total annual catch and overall effort in the MPA. The cross-referencing of data from a fishing logbook with data from landings or surveys on board vessels fishing in the MPA is particularly interesting.

Difficulties, advantages / Disadvantages

- This method requires the commitment of the fishers who fill in the logbooks to the management project and a relationship of trust.

Advantages

- Low-cost data collection and the precision adapted to the MPA and resource management objectives that can be agreed upon with fishers
- The fishing logbook can be a vector for raising awareness to good practices and for dialogue between managers and fishers
- Between meetings and contacts with MPA managers, the logbook is a means of reporting observations made by professional fishers who are permanently at sea (watch)

Disadvantages

- Inaccuracy related to the data reporting process (partial filling of logs, errors, exaggeration, minimisation). Cross-referencing with boarding data can compensate for this defect or at least allow the error to be assessed, reported and an encouragement to fill in the data correctly.
- Ergonomics of daily logs and speed of entry are favoured to the detriment of data details
- Risk of forgetting to report fishing trips or gear without catches (zeros are important)
- The completion of the logbook adds to the national reporting obligations (ensure that the data collected are complementary)
- Changes may be necessary and complicate the analysis of data over the long term
- Analysis of the data to be done internally or through a scientific partnership

Material

- If the paper version is selected, the logbooks to be distributed must be printed. A follow-up of the delivery and recovery of the logbooks should be organised; for example during an annual meeting related to professional fishing. Be careful, plan a database for data entry; this can be time-consuming (not to be underestimated).
- If the digital version of the fishing logbook is chosen, it may be necessary to plan for the design of a website allowing online data entry, maintenance and a data storage server.
- In both cases, the data must be entered at least on an Excel® spreadsheet and it is recommended, especially if the number of fishers is large, to enter them in a database. Plan in the short or long term the design of an Access® type database.

€ Estimated costs (€: low, €€: medium, €€€: high)

€€ Human resources

€ If the data entry is not done internally, specific service for data entry
Provide a database for data entry; this can be time-consuming (not to be underestimated) and carried out internally, by partner scientists or by a subcontractor.

Significant investment in the first year for the development of the tool and then maintenance. A mutualisation is possible between MPAs, or even at national level

€ Investment / material in the case of paper, computer format

€€ Data analysis

Administrative procedures, legal provisions

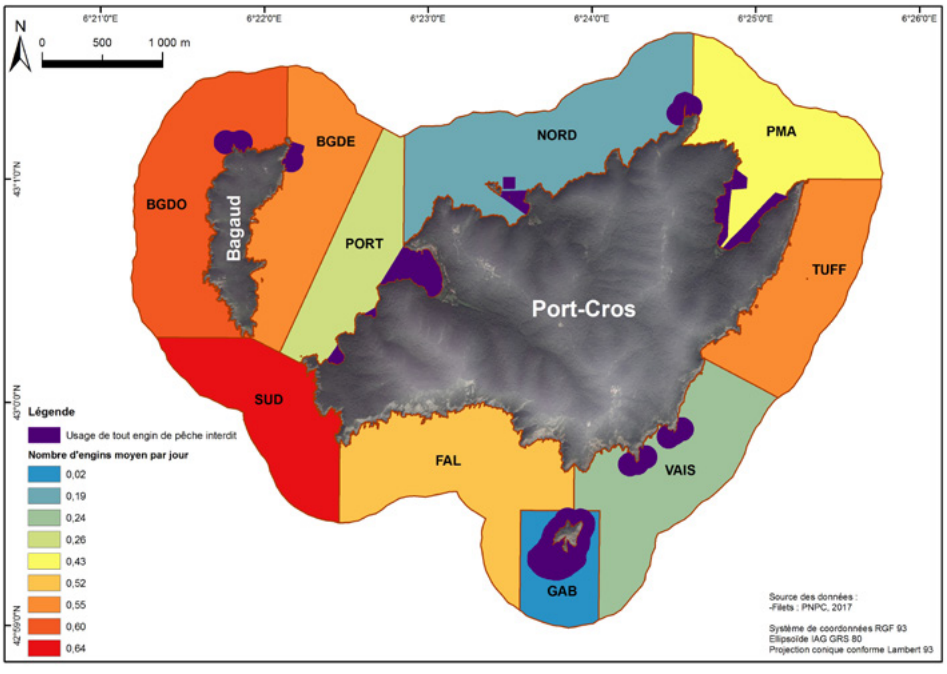
- In the case of a digital version, the logbook can be hosted on the website of the MPA or the fishers' organisation (prud'homie, regional fisheries committee). It can also be hosted on a dedicated website and a domain name will have to be created.
- Anonymity regarding fishers / vessels. Respect for statistical confidentiality: aggregation of catches from at least 3 vessels per category.

Type of results obtained / Metrics

- Basic metrics:
  - number of gear / sector / day
  - number of professional fishing vessels / sector / day
  - port of origin of fishers operating in the area (through vessel registration)
  - total catch of the day and main target species (kg)
- Derived metrics:
  - average number of gear / sector / season or per year
  - average number of boats per season or per year
  - total annual catch in the MPA
  - Average CPUE / sector / season or by year
  - CPUE all species total, target species / sector / day

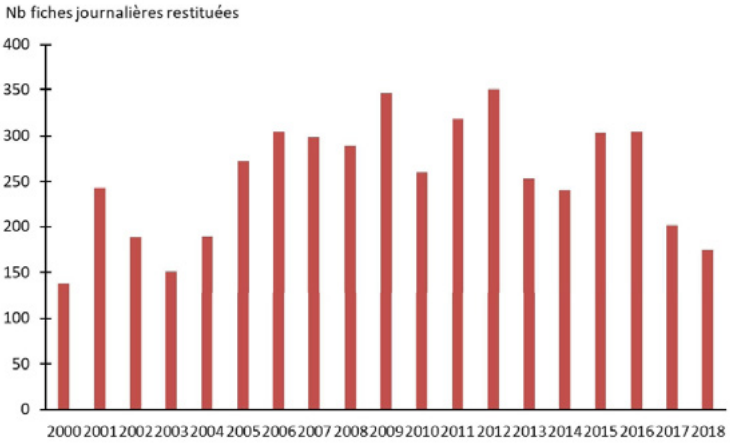
Graphical representations

- Maps, tables, histogrammes of site use by temporal (day, season, year) and spatial (sector / area) variables
- Tables, histogrammes of the different métiers, gear used, catches, CPUE, discards



Map of the density of fishing gear in the different sectors of the MPA declared in the fishing logs by professional fishers who have been active in the MPA (here example of Port-Cros national Park; GIS Posidonie)

Number of daily records (days / trips to Port-Cros National Park) returned from the diaries between 2000 and 2018 (GIS Posidonie and Port-Cros National Park).



To go further

- Cadiou *et al.*, 2009. The management of artisanal fishing within the Marine Protected Area of the Port-Cros National Park (northwest Mediterranean Sea): a success story ? ICES J. Mar. Sci, 66: 41-49.
- Rouanet *et al.*, 2020. Synthèse du suivi de l'effort de la pêche professionnelle dans les eaux de Port-Cros – 2000-2018. Partenariat Parc national de Port-Cros & GIS Posidonie, GIS Posidonie publ., Fr. : 71 pages + annexes.

Example of a daily trip log from the professional fishing logbook of the Port-Cros national Park set up in 2000 (GIS Posidonie)

Date : / /

Type* d'engin	Nombre de pièces ou hameçons	Longueur	Maille	Profondeur	Temps de calée

*. T : trémail ; M : maillant ; Mo : monofil ; B : battude, P : palangre ; N : nasse

Positionner sur la carte les engins relevés par une croix

Captures :

Espèce	Nombre d'individus			Poids (kg)
	petit	moyen	gros	
Bouillabaisse				
Soupe				
Sar commun				
Vérade (tête noire)				
Sulle (museau pointu)				
Daurade				
Pagre				
Pageot				
Denti				
Canthre				
Saupe				

Espèce	Nombre d'individus			Poids (kg)
	petit	moyen	gros	
Loup				
St Pierre				
Mérou				
Corb				
Chapon				
Rouget				
Baudroie (lotte)				
Mostelle				
Congre/murène				
Raie				
Pélamide/liche				
Seiche				
Langouste				
Grande cigale				
Gritte				
Homard				

Rejets	Espèces principales :
	Poids (estimé) rejeté (kg) :

Observations : (autres prises, indications sur le milieu, météo, Caulerpe...)

Catch declaration, fishing logs, user initiatives

Assessment of catches and associated recreational fishing effort by declaration from fishing logbooks filled in by fishers

© FNPF

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the approach and tool, acceptance of the practitioners
- Tool to be set up within the framework of a charter with federations, associations

REMARKS

A preliminary characterisation study of the parent population of recreational fishers is recommended to ensure that the results obtained and the interpretations resulting from the analysis of the fishing logbooks are well represented

The combination of fishing effort and catch information in a single protocol allows for optimisation in data collection and information entry for the fisher. The multiplicity of data entry media can be a barrier for fishers

ACTIVITIES CONCERNED

Shore fishing, on foot, underwater, on board

Objectives and expected results

Objectives

- Assess the use of the site by recreational fishers: the main activities carried out, their density in the MPA and their interaction with the resource and natural habitats
- Be familiar with fishing practices, the types of fishing gear used, the species targeted / sought after and caught according to gear type and season
- Know the spatial (maps) and temporal distribution of these sampling activities on site (days, seasons, years)
- Know the spatial (maps) and temporal distribution of catches taken (CPUE) by activity, by gear category, taken from the site (days, seasons, years)
- Be able to superimpose this distribution with a habitat mapping
- Better manage uses as part of a management plan, reduce conflicts
- Define and locate any vulnerable areas
- Demonstrate the reserve effect of an area closed to all fishing practices (if applicable)
- Assess the means to be put in place to carry out awareness-raising actions
- Supplement, where appropriate, the data acquired by other protocols (surveys, countings from the coast, aerial counts, fishing logbooks, etc.).

Expected results

- Quantitative assessments (number of vessels, fishers, gear) of recreational fishing effort
- Qualitative and / or quantitative assessments (species, number, biomass) of catches made by fishers: total catch and main target species
- Evaluation of activities, practices in the MPA
- Identification of target / sought after species
- Evaluation of CPUE (after analysis of reported catches)
- Quantified and spatialised elements to implement appropriate management measures.

Protocol description

- The MPA provides the fisher with a fishing logbook that he can / should fill in on each trip. Ideally, the logbook should be filled in just after the trip in order to avoid errors.
- In order to simplify entries, the logbook is composed of daily logs where the fisher can accurately describe the various information related to the fishing trip. It is specified whether his fishing day includes all or part of the fishing operations reported in the MPA

SAMPLING: TIME UNITS

MONITORING PERIODICITY

The protocol can be reproduced annually

Frequency

The logbook must be completed at each fishing trip in the MPA

Duration

A few minutes, depending on the fishing effort and the catches made during the trip

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA or share of catches in the MPA in relation to the total catch of fishing areas

Monitoring subunits

Management area categories, specific site

FEEDBACK FROM EXPERIENCE

- Port-Cros National Park (FR)

and if he did not catch anything at all. The entry of the logbook and daily trip forms must remain easy and quick for the fisher (sort out the essential information).

- The fishing logbook can be in paper format or in digital format online on the Internet. The paper format should be preferred when users' access to the Internet is poor.
- The handing over of the forms to the MPA can be done in different ways:
  - automatically on a database of the investigating body if the logbook is online
  - following regular calls (periodicity to be defined) from the surveyor to fishers to collect data from the past period. This type of data collection makes it possible to maintain regular exchanges with the fishers
  - delivered to the MPA or the investigating body (postal dispatch, hand-delivery) on a periodicity to be defined (bi-monthly, semi-annual, annual). A new fishing logbook is then issued in exchange.
- The fishing logbook can be distributed to volunteer fishers recruited following a preliminary survey, for example (see corresponding sheet). Keeping a logbook may also be required in the framework of charters or fishing licences.
- Information to be collected by fishing logbooks:
  - Information on the site and the day's conditions:
    - › date, duration of the trip, location (name of the fishing site, GPS points, zoning map based on visual cues easily identifiable in the field: cape, port, islet, etc.), type of mooring used (if using a boat).
  - Practices:
    - › type of fishing (onboard, from the shore, underwater, on foot), fishing gear used, numbers used by gear type, duration of fishing per gear, types of bait used.
  - Catches made:
    - › for each gear: name of species caught, number, size, weight (or provide small / medium / large grids), discards (name of species, specify reason)
    - › if no capture, indicate it.
  - Additional information:
    - › other users met
    - › invasive species, pollution
    - › free comments.
- The logbook can include a first section in the form of a survey to better understand the fisher's habits and identify any potential changes (initial profile to new profile). This information is only required once per logbook:
  - Fisher's identifier:
    - › gender, year of birth / age range, socio-professional categories, main place of residence (city / region / country).
  - Boat information (on-board, underwater fishing):
    - › vessel registration / name, size, type of vessel, port of registry or launching.
  - Fishing habits:
    - › fisher's experience (number of years of practice)
    - › periods of practice during the year (months of activity), the week, the day (morning, evening), the average number of trips per year (if possible by type of fishing) distinguish summer / winter if possible, the average duration of trips
    - › proportion of annual trips in the MPA
    - › types of fishing practiced, gear used by type of fishing, sites practiced (by type of fishing)
    - › volume of catches (annual per trip or total annual), main species fished during the year
    - › changes in fishing techniques used (increase in the number of gear, change in gear type, change in fishing technique).
  - Additional information:
    - › factors influencing the choice of fishing site
    - › main reasons for practice (leisure, food resource required)
    - › feelings about the evolution of fishing on the site / MPA (increase / decrease in catches, increase / decrease in site use)
    - › evolution of resources, diversity of catches, size / weight, number.
- Feedback from data analysis should be encouraged to maintain the support of fishers and their participation in data collection. This can be done by automatic analyses (yields by season, species, type of fishing carried out per trip, on site, etc.) in the case of an

online logbook or during an annual feedback meeting to be organised by the MPA (with the investigating body if necessary).

Implementation advice

- As with all sampling plans, the question of panel representativeness is paramount. It is therefore important to have information on the profile of volunteer fishers. In order to ensure a good weighting, it is strongly recommended to carry out a preliminary survey (by telephone or on site) to define the representative parent population of fishers (see corresponding sheet). The results obtained will thus be compared with the parent population.
- It will be necessary to renew this framing work (every 5 years for example) to understand the changes in the population of fishers and new practices.
- Ensure that certain categories of fishers are not under-represented because they are difficult to contact (e.g. occasional fishers).
- The manager and possibly the associated scientists must guarantee the confidentiality of the data (global analysis only).
- In the entry forms, provide multiple choice boxes or drop-down menus to limit errors (see disadvantages).
- The fishing logbook is a tool for fishers and managers alike. It is the ultimate co-management tool that provides information specifically related to the MPA and makes it possible to assess the total annual catch and overall effort in the MPA. The cross-referencing of data from a fishing logbook with data from shore or sea surveys of fishers fishing in the MPA is particularly interesting.
- The data collected through this logbook (if it is completed sincerely) or surveys, can be used to raise awareness among recreational fishers about the impact of their practices.

Difficulties, advantages / Disadvantages

- This method requires the support of fishers who fill out the logbooks in the long term (occasional or incomplete data cannot be used).

Advantages

- Low-cost data collection
- Can provide a lot of data and over the annual period, if users are motivated
- The fishing logbook can be a vector for raising awareness on good practices and for dialogue between managers and fishers

Disadvantages

- Inaccuracies related to the data reporting process (identification errors, exaggeration, minimisation, omission) not always compensated by the number of notebooks returned
- Difficulty in maintaining user motivation in the medium to long term
- Potentially high non-return rate of fishing logbooks (role of the facilitator must be important)
- Ergonomics of daily logs and speed of entry are favoured to the detriment of data details
- Risk of non-reporting during fishing trips without catch (zeros are important)
- No control of declarations
- Risk of under-sampling of the population of fishers (preliminary study required), occasional fishers or those with no access to the Internet
- Changes may be necessary and complicate the analysis of data over the long term
- Analysis of the data to be done internally or in scientific partnership

Material

- If the digital version of the fishing logbook is used, it may be necessary to plan for the design of a website to allow online data entry, maintenance, design of a database and a data storage server.
- If the paper version is selected, it is necessary to print logbooks to be distributed in large numbers and to plan time and staff to monitor the delivery and retrieval of the logbooks. Seek the collaboration of fishing associations and federations.
- In both cases, data must be entered at least on an Excel® spreadsheet and it is recommended, especially if the number of fishers is large, to enter them in a database. Plan the design of a database for the entry and storage of Access® type data, for example; this can be time-consuming (not to be underestimated).

€ Estimated costs (€: low, €€: medium, €€€: high)

€€ Human resources (help from internship students and / or volunteers can reduce costs)

€ Specific service for data collection
Significant investment in the first year for the development of the tool and then maintenance, but possible pooling at national level or between MPAs

€ Investment / material in the case of a paper format

€€ Data analysis

Administrative procedures, legal provisions

- In the case of a digital version, the logbook can be hosted on the MPA's website. It can be hosted on a separate website, and a domain name must be created.

Type of results obtained / Metrics

- Basic metrics by activity:
  - number of boats / sectors/day
  - number of fishers / boats or number of fishers (on board)
  - number of gear / fishers
  - number of fishers / sector / day
- Derived metrics :
  - average number of gear / sector / season or per year
  - average number of boats per season or per year
  - total annual catch in the MPA from recreational fisheries or by activity
  - Average CPUE / sector / season or by year
  - CPUE all species total, target species / sector / day

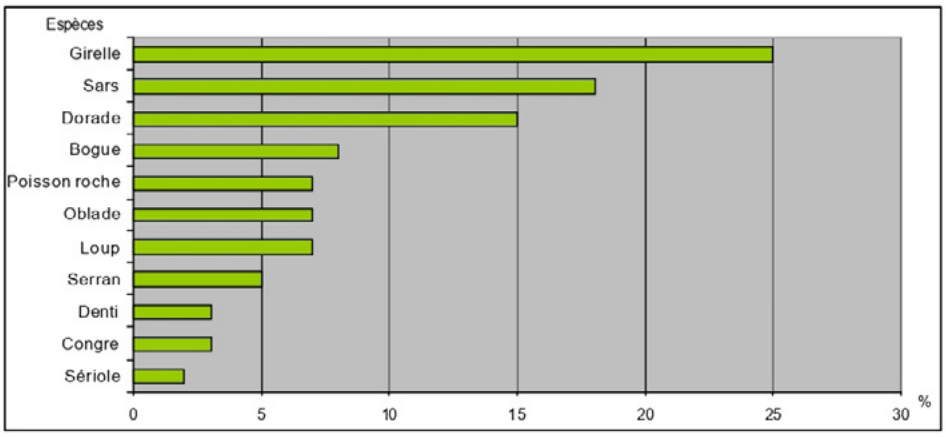
Graphical representations

- Tables, histogrammes of the different activities, gear used, catches, CPUE, discards
- Maps, tables, histogrammes of site use according to temporal (day, season, year) and spatial (sector / zone) variables

Average number of people on board vessels engaged in underwater fishing or angling activities in the MPA during the summer (here example of Porquerolles, Port-Cros National Park; GIS Posidonie)

		Nombre moyen de personnes par bateau
Chasse sous-marine	Matin	1.0
	Après-midi	1.6
	Moyenne	1.4
Pêche amateur	Matin	1.8
	Après-midi	2.6
	Moyenne	2.5

Species (vernacular names) of fish sought and cited by anglers operating in the MPA during the summer period (here example of Porquerolles, Port-Cros National Park; GIS Posidonie)



To go further

- Gamp *et al.*, 2016. Pêche récréative : un guide pour vous orienter dans vos méthodes de suivis – Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des aires marines protégées, Fr. : 199 p.
- Peirache *et al.*, 2013. Quantification de l'effort de pêche de plaisance via le web. Parc national de Port-Cros. Projet MedPAN Nord. 15 p.
- http://carnet-peche.espaces-naturels.fr/
- https://www.sortiepecheaubar.fr/

Catch declaration, fishing logs, user initiatives

Contribution of participatory sciences to the study and monitoring of professional and recreational fishing

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CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

To know the initiatives and promoters of participatory science projects in the MPA country or region

REMARKS

This sheet does not provide a standard method because there are many participatory science initiatives. It provides key elements and examples to help the manager identify initiatives that can provide data and raise awareness on issues related to fishing and fisheries management in and around the MPA

ACTIVITIES CONCERNED

All of them

Objectives and expected results

Objectives

- Identify participatory science projects to collect data on professional and recreational fishing
- Support project leaders in the implementation of initiatives
- Participate in the definition and construction of the protocol for the participatory science project
- Beyond the partnership with professional fishers, have a watch, a sentinel network on fishing and the state of the resource

Expected results

- Acquire data complementary to the scientific protocols put in place elsewhere
- Involve recreational fishers and other users in the monitoring and management of the MPA
- Monitor the use of the MPA by recreational fishers, the state of the resource
- Feedback on particular events (new fishing practice, new species observed, mortality phenomena, etc.)
- Inform on illegal practices
- Raise awareness of users through involvement in a participatory project.

Protocol description

- Participatory monitoring is based on a voluntary dimension and a commitment over time on the part of the participants in the monitoring. They can be applied on a large scale with the same protocol and be regular over time if the number of volunteers involved ensures that sufficient quantity and quality of data is collected to ensure representative processing and analysis capacity (Gamp *et al.*, 2016).
- Participatory monitoring requires the implementation of a standardised, stable over time (for long-term monitoring) and scientifically robust protocol. To do this, do not hesitate to approach scientists who are specialists in the subject matter and the technique used by the protocol, but also advisors in sampling strategy. Do not take the risk of collecting data on a large scale that is statistically and / or cartographically inoperable.
- Protocols must remain simple for participants in order to be widely applied. They must be unambiguous in the terms used or schemes used. It will be necessary to ensure that volunteers are trained in the implementation of the protocol (with regular refresher courses and calibrations) and to plan regular exchange times.

SAMPLING: TIME UNITS

Monitoring periodicity

Exchanges with project supporting structures can be carried out throughout the year.

Direct exchanges with users regarding lost fishing gear the day before

Frequency

Annual review with project management structures. Possibly mid-year before the summer season (more appropriate for most monitorings)

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA and around

Monitoring subunits

Areas by management category: total, partial protection, regulation of certain fishing activities such as authorised / prohibited hunting, for example

FEEDBACK FROM EXPERIENCE

- http://www.marinschercheurs.org
- https://www.mio.univ-amu.fr/ghostmed/en
- https://comber.hcmr.gr

- The data entry media and information collection methods (scorecard, notebook, internet, telephone) must be considered during the construction of the protocol, in particular the time required for this data entry: is it the user / participant who enters data? what tool is available to him in this case? is it the host? If necessary, allow time for this task. Ensure that the data is correctly entered by encouraging the implementation of a verification and validation process. The structure in charge of data analysis must be designated when the protocol is implemented.
- Annual reviews are to be planned and interim reviews are recommended. These assessments can be carried out by the supporting structure of the participatory science project or by the MPA (to be defined when the protocol is implemented). The objectives of these reports are to: (i) ensure the proper application of the protocol, be informed of the difficulties encountered in practice; (ii) present the results obtained to participants, other users and MPA agents, (iii) motivate participants to continue, (iv) collect comments and adapt or develop the protocol together, if necessary.
- The study and monitoring protocols can be of different types:
  - **observation of site use** by visual census from the shore / land: see corresponding sheets
  - **GPS signaling** of their own fishing activity (effort allocation)
  - **monitoring of catches** by the restitution of recreational fishing logbooks: see corresponding sheet.
  - **monitoring of fish populations by visual census** (see corresponding sheet). The protocol must be simplified compared to a protocol for scientists. This concerns the list of species (identification may be difficult for non-scientists), size estimation. Simplified protocols such as "target species counting" or "FAST counting" respond well to the demands of participatory science (Ben Lamine *et al.*, 2018)
  - **response to surveys on fishing effort, resources, perceptions** for recreational fishers (see corresponding sheet) or scuba divers for underwater observations (collaboration with diving structures; e. g. Bramanti *et al.*, 2011), but also for other users (e. g. Zenetos *et al.*, 2013). In addition to the general information presented in the survey sheets, the questionnaire should provide information on the species / population studied, its spatial location (in and outside the MPA), evolution over time (presence, size, abundance change over time), physical integrity (e.g. broken branches for red coral, hook in a fish's mouth), health status of the resource,
  - **identification of lost fishing gear**. Along land or sea routes in snorkel or scuba gear (diver protocol), professional fishing gear and equipment (net end, longline, trap) and recreational fishing gear (fishing line, hook, sinker, bait box) are recorded (and possibly collected near the edge), either by GPS or by location on a map. A scoring sheet is therefore provided on which the volunteer notes the date, the place of observation (map with name of the place provided to avoid name confusion), the type of gear, the presence or absence of animals caught by the gear, the depth (if underwater). The protocol can be carried out over time, when the opportunity arises or applied during a special operation organised by the MPA during which the harvested gear and waste (quality, number, weight) will be identified. This type of operation can also be used to raise awareness. This information can also be transmitted by fishing professionals when they break or lose a gear at sea.
    Operations can be organised with the MPA to subsequently collect the waste gear and dispose of it properly. Be careful, especially in the case of nets, trawls and dredges, which, if they are concretioned, can cause more damage when they are removed; the best thing is to prohibit volunteers from recovering them and doing so under their own control or with professional divers.
    This theme can also be an introduction if no collaboration has yet been established with professional fishers. The recovery of lost gear in the MPA is a common concern and can be organised together.
    Two FAO guides can be consulted ahead of time: Macfadyen *et al.*, 2009; Gilman *et al.*, 2016.
  - **biological watch at sea**. Among the information that can be collected by users at sea, the stranding of dead fish species, the arrival of new species can be reported by informed observers (divers, amateur fishers) such as the development of invasive species or mass mortality phenomena.

Implementation advice

- Remember that these protocols are carried out by voluntary participants on their own time
- A participatory science protocol cannot be expected to have the same requirement as a scientific protocol (e.g. taxonomy, accuracy of measurements, rigour of sampling strategy).
- The lack of precision of a scientific protocol can be at least partially offset by the very large amount of data collected by participatory sciences.
- Provide a process and means for validating data, and signals
- Be careful not to multiply initiatives (which may be redundant) on the territory. This can lead to a loss of readability.
- An evolutionary dimension of the protocol based on suggestions from participants is to be expected / considered while maintaining scientific rigour and the need for standardised long-term monitoring (beware of biases or difficulties caused by changes in data collection methods).
- A follow-up, sometimes a support, must be ensured to maintain the motivation of the volunteers / participants and there lies the difficulty: participatory science won't happen by itself. Supervision by volunteers and the associative community can be useful to maintain data collection over time, to carry out the analysis of these data or their transfer to specialists and then organise the feedback of information to users and participants. The human resources to be put in place and maintained over time are therefore not negligible to achieve the goals defined at the outset and the acquisition of reliable and usable data.
- Associate the MPA with a structure specialising in participatory sciences as part of a joint project or in partnership with scientists

Difficulties, advantages / Disadvantages

Advantages

- Low-cost data collection
- Acquisition of a large dataset (related to the number and involvement of participants)
- Monitors fishing practices and the environment
- Appropriation of management issues by participants
- Tools for awareness-raising and education on good practices

Disadvantages

- Lack of precision of the data
- Data that may be unreliable and lack rigour in their acquisitions
- Possible confusion in species identification
- Deviation from the initial protocol, non-compliance with instructions
- Risk of demotivation of participants over time
- Costs of monitoring and support of the tools implemented
- Data validation and analysis costs

Material

- If the role of the MPA is to ensure the link and exchanges with the project's supporting structures: none
- If the MPA has a role of monitoring facilitator:
  - protocol presentation booklet

- support and scoring sheet
- measuring tools: ruler, balance, quadrat
- camera
- communications objects (poster, flyer, website, social networks, t-shirt) to promote the participatory science project
- database / Excel table to enter and archive data

€ Estimated costs (€: low, €€: medium, €€€: high)

€	Human resources (link with the structures supporting the project) or **€€€** (if organiser and facilitator of participatory science monitoring
0	Specific service for data collection
0	Investment / material but **€€** if facilitator of participatory science
€€	Data analysis

Administrative procedures, legal provisions

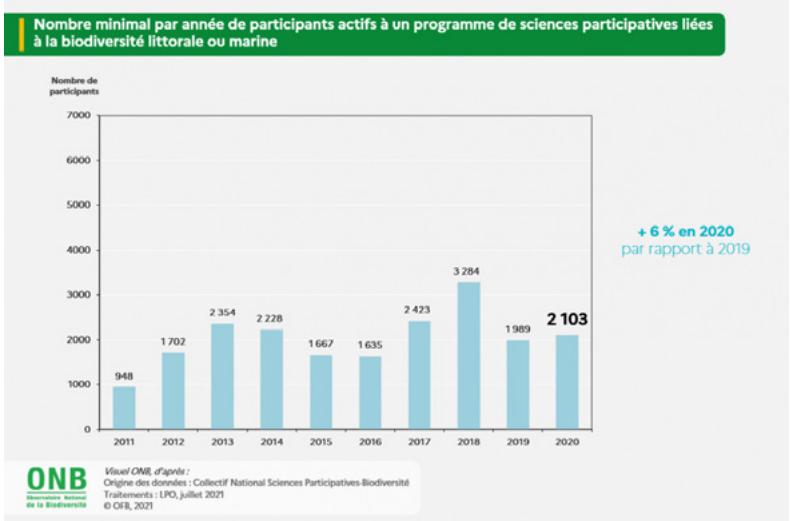
- None

Type of results obtained / Metrics

- Maps of the territories concerned by the different participatory science projects
- Basic metrics:
  - list of participatory science monitoring
  - number of participatory science monitorings
  - number of days of data acquisition
  - number of completed forms or signage
  - list of lost fishing gear or types of waste collected
  - number or weight of fishing gear or fishing waste collected during the annual monitoring
- Derived metrics:
  - average number of monitorings / year
  - number of monitoring categories / year
  - number of days of data acquisition / monitoring / year

Graphical representations

- Tables, histogrammes of data collection effort by protocol type according to temporal (day, season, year) and spatial (in/outside MPA, sector) variables
- Maps of the territories concerned by the various monitorings



Minimum number per year of active participants in a participatory science programme related to coastal or marine biodiversity in France (OFB, 2021

To go further

- Ben Lamine *et al.*, 2018. Can citizen science contribute to fish assemblages monitoring in under studied areas? The case study of Tunisian marine protected areas. Estuarine, Coastal and Shelf Science, 200: 420-427.
- Bramanti *et al.*, 2011. Involvement of recreational scuba divers in emblematic species monitoring: The case of Mediterranean red coral (*Corallium rubrum*). Journal for Nature Conservation, 19: 312-318.
- Gamp *et al.*, 2016. Pêche récréative : un guide pour vous orienter dans vos méthodes de suivis – Suivi et caractérisation de la pêche récréative dans les aires marines protégées. Agence des aires marines protégées, Fr. : 199 p.
- Gilman *et al.*, 2016. Abandoned, lost or otherwise discarded gillnets and trammel nets. Methods to estimate ghost fishing mortality, and the status of regional monitoring and management. FAO Fisheries and Aquaculture Technical Paper N°600. Rome. Italy. 96 p.
- Macfadyen *et al.*, 2009. Abandoned, lost or otherwise discarded fishing gear. UNEP Regional Seas Reports and Studies, No. 185; FAO Fisheries and Aquaculture Technical Paper, N°523. Rome, UNEP/FAO. 2009. 115 pp.
- Zenetos *et al.*, 2013. The role played by citizen scientists in monitoring marine alien species in Greece. Cah. Biol. Mar., 54: 419-426.

Assessment of catches and associated professional fishing effort by survey: case of fixed fisheries (tunny nets, cherfiyas, dalyan)

© Nicolas Millot

CONDITIONS FOR THE APPLICATION OF THE PROTOCOL

- Presentation of the monitoring to fishers and their local and regional representatives
- Acceptance by professionals

REMARKS

These are fixed enclosures installed perpendicular to the currents to trap fish.

The enclosure of the fishing gear leads the fish to a catch chamber that ends in a death chamber where the catch is taken.

ACTIVITIES CONCERNED

This sheet refers to fishing techniques using stationary nets deployed at sea: traps (NW Mediterranean), cherfiya (Maghreb), Dalyan (Turkey).

Objectives and expected results

Objectives

- Know the characteristics of the fishing gear used, the species targeted / sought after and caught according to the season
- Assess the catches made by professional fishers ¬on a seasonal or year-round basis
- Determine a calendar of activity for fixed fisheries: site use rate
- Assess the impact on the resource by having precise access to harvests (target species and by-catch) and discards
- Assess fishing effort more accurately by having access to gear characteristics r and practices (in particular the duration between 2 net lifts)
- Have information on the profile of professional fishers practising these fisheries and working on the territory or around the MPA: home port, diversification or not of fishing techniques, common or individual equipment
- Know the spatial (maps) and temporal distribution of these fixed fisheries on the site (days, seasons, years), the rotations of the fishing posts
- Be able to overlay this distribution on a habitat map
- Assess the impact of this fishery on benthic communities
- Reconstruct the history of these fixed fisheries in the MPA and the associated regulations
- Determine the knowledge of fishers on the interactions between technical characteristics and the species they target (seasonal migrations, genetics)
- Determine the factors that condition the diversity of behaviours observed: process of appropriation of the territory, acceptance, adherence or rejection of certain management measures
- Manage the sustainability of this fishery within the framework of a management plan
- Define and locate possible vulnerable areas and sensitive periods for species
- Demonstrate the reserve effect of an area closed to all fishing practices (if applicable)

Expected results

- Fishing effort assessments: number of stationary gears, barriers, fishing periods, duration between 2 harvests
- Precise quantitative assessments of catches (species, numbers, biomass)
- Assessment of catch per unit effort (CPUE) and bycatch
- Number of shifts worked per fisher, per MPA area or near MPA, per day
- Number of days worked by fishers on each fixed post

SAMPLING: TIME UNITS

Monitoring periodicity

The protocol can be repeated every month, every season or every year

Frequency

Several trips per month, per season, per métier type is a tight sample. A series of trips per season makes it possible to characterise the activity and to calculate average CPUE by type of gear or by métier

Duration

Variable according to fishing effort and abundance of catches, half-day or full-day trips

SAMPLING: SPATIAL UNITS

Appropriate surface unit

MPA or share of fixed posts located in or near the MPA

Monitoring sub-units

Categories of management areas (areas where one or more fishing activities are regulated), specific site (bottom/bay entrance)

FEEDBACK FROM EXPERIENCE

- Kerkennah Islands, La Chebba (TN)
- Köyceğiz Lagoon (TR)
- Syndicat Mixte de l'Etang de Thau, Groupement d'Intérêt Public pour la Réhabilitation de l'Etang de Berre (FR)

- Typology of professional fishers (origin, seasonality of practices, other fishing activities practised: passive gear fishing for example)
- Evaluation of métiers, practices
- Figures on the impact of this fishery on the populations
- Quantified and spatialised elements to set up adapted management measures
- Determining the knowledge of fishers about the biology of the species they target and catch, and the dynamics of stock recovery

Protocol description

- The MPA provides an agent or scientist who investigates with a professional fisher and follows his activities during the day's trip. Unlike scientific fisheries, the fisher acts as usual, the observer not giving any instructions. The fishing location is noted (recommended zoning, identical to the zoning used for gear or boat counts) as well as the time of the fishing operation. The characteristics of the gear are noted (type, number of chambers, mesh size if applicable, duration between 2 harvests). The catches removed by the fisher is measured and weighed, whether it is kept or not, put back in the fish pen (waiting for a more suitable time to be harvested - sale, size of the catch) or outside.
- During the trip, which can last several hours, a dialogue is established with the fisher concerning practices, fishing posts, local conditions (current direction, tides, etc.), the evolution of catches and all sorts of interesting observations concerning the species and the environment, the functioning of these fixed fisheries (private property / lease, rotation of posts, maintenance of fishing gear, etc.), the impact of uses, potential conflicts with other users. A lot of explanations can be given about the fishing activities and the context in the MPA. It is strongly recommended that notes are taken to preserve this information and make it accessible to other monitoring or MPA partners.
- Notes are taken on a waterproof medium (diving slate or waterproof paper), for each operation: set or lift.
- Information to be collected during the on-board survey:
  - Date
  - Fishing location: name of station or GPS point
  - Time of operation
  - Gear parameters: gear type and characteristics (length, area, number of chambers, mesh size if applicable), fishing depth
  - Time since the last harvest operation. Be careful to differentiate between maintenance and servicing operations, which must be noted separately to avoid distortions in the calculation of the CPUE.
  - Retained catches: species name (Latin recommended), size, weight, sex and reproductive status (particular livery, presence of eggs), if visible; if no catches, indicate it (zeros are important)
  - Catch returned to the fish pen: species name (Latin recommended), size, weight, sex and reproductive status (particular livery, presence of eggs), if visible; if not returned to the fish pen, indicate it (zeros are important)
  - Catch discarded from the fish pen: reason (size under catch limit, species not marketed, damaged catch or eaten by 'fleas' or attacked by a predator), species name (Latin recommended), size, weight, sex and reproductive status (particular livery, presence of eggs), if visible; if no discard, indicate it (zeros are important)
  - Observations: other users encountered, invasive species, pollution, any comments concerning habitats and species, users, the MPA and management. These summarised remarks can be very useful for interpreting monitoring data or for management purposes.
- Photographs are taken during boarding and are used to identify species when in doubt (do not hesitate to take several photos (dorsal and ventral views for example). They are also useful to illustrate reports and the presentation of results and to create a documentary collection on fishing in the MPA.

- Measures should be taken quickly to minimise the handling of the fish. It is recommended that gloves be used to reduce the risk of letting the fish escape. The observer can store the fish directly according to the fisher's instructions in a cooler, jute bag, out of the sun etc. Sub-sampling is avoided as long as there is sufficient time to process the catch between the lifting of 2 stations.
- The measurement of fish is the standard length (Lst) and the total length (Lt) to the nearest 0.5 cm (see glossary), that of crustaceans is the length of the cephalothorax; for molluscs, weighing is preferable.
- Biomass is measured using a waterproof electronic scale
- After the boarding, the data is copied on a mission notebook which gathers all the data of the campaign. It is strongly advised to 'clean up' the data collected as soon as possible. This is an important step in the validation of the data. Some oversights can be corrected. The species must be checked one last time using photos taken on board when in doubt and the results compared, if necessary, with other observers on board other vessels on the same day or at the same time.
- The validated data can be entered later or at the time of data analysis into a database, at least in an Excel® spreadsheet.
- An annual review of the results of the monitoring should be organised by the MPA with all the participants in the surveys, to share information, keep fishers on board, involve them in the monitoring and take joint management measures.

Implementation tips

- The support of fishers is essential for the assessment of the fishing effort, the practices and the harvests.
- As with all sampling plans, the question of the representativeness of the panel is paramount. It is therefore important, beforehand, to have information on existing and active fixed stations, the métiers practised by fishers and according to the seasons, to choose the métiers that we want to monitor (importance of the number of practitioners and stations, target species of importance for conservation or management, etc.) and to carry out stratified sampling with many replicates per métier (because of the high spatial and temporal variability of catches).
- A preliminary survey (maritime authorities, Ministry of Fisheries or fishers's representatives on site) is recommended to define the representative parent population of fishers (see corresponding sheet). However, it is not advisable to extrapolate to the year from the few dozen trips made per season without the assistance of a fisheries scientist.
- Know-how can vary significantly from one fisher to another depending on his or her experience. In the case of a voluntary approach, it will be necessary to ensure that certain types of fishers are not under-represented (e.g. novice, experienced, retired, occasional fisher on site or using several landing points).
- The structural condition of fixed fisheries, the level of maintenance and upkeep can significantly affect the performance of the gear and the catches taken.
- It is important to sample fixed stations outside the managed areas to be able to assess the effectiveness of the management applied in the MPA or in certain areas of the MPA.
- The on-board observer shall not be entitled to participate in fishing operations. He must ensure that he does not interfere with the manoeuvre and does not delay the operations when the vessel arrives in port.
- Observers can be members of the management team, scientists, contractors, students and trained interns.
- The number of fish traps, their characteristics (surface, number of chambers, mesh size if applicable) and the time between 2 sampling are essential criteria to be noted in order to be able to reduce the catches to a standardised unit.
- Anonymity must be guaranteed to fishers at the time of data sharing, so the data is aggregated and returned in a global way.

- Precise results on catches and discards by species, including CPUE, are an important basis for management measures and discussions with fishers.
- It is advisable to board with a nautical chart or zoning when the area is not perfectly known.
- The archiving of data and photos taken on board must be done by day, by ship, by campaign, to make the document collection usable.

Difficulties, advantages / Disadvantages

- This method requires a strong commitment from the fishers in the monitoring, who agree to take observers on board their vessel for several hours of fishing, to trust and to share their knowledge.

Advantages

- Accuracy of catch data and access to by-catch and discards
- Data collection can be done internally, shared or delegated to partner scientists or consultancies
- This type of monitoring makes it possible to maintain regular exchanges with the fishers, creates the opportunity for long exchanges on board the fishing vessel and is very instructive for agents who are not familiar with fishing
- Data sharing is a good reason to organise an annual fishery meeting and to discuss management measures between managers, fishers and scientists

Disadvantages

- Time-consuming and tiring sampling
- Time for copying and validating data should not be under-estimated
- Optimisation of this sampling when the observers are known, experienced and appreciated by the fishers; difficulties linked to the relationships between people
- Issue with allowing an additional person on board, especially on small boats (safety equipment)
- Difficulty for the professional fisher to allow a person responsible for fisheries policing to come on board as an observer (conflict of interest); in this case, delegate the observation to scientists for example.
- Biases linked to weighing at sea (errors due to the movements of the vessel). This error, which can reach several dozen grams, is compensated for by the number of individuals weighed, in view of the application of size-weight relationships that are often poorly adapted to the area. This is a choice to make.
- Difficulty in calculating CPUE when taking into account catches that are not taken but are returned to the fish pen for later harvest
- Do not underestimate the time or cost of using the data after the fact

Material

- Waterproof slate or waterproof paper, pencil, possibly a voice recorder
- Fish ruler, tape measure for large or difficult to handle fish
- Waterproof scale
- Camera and photo template, GoPro® type handheld video camera
- Appropriate clothing: boots and possibly overalls and gloves for handling fish or fish boxes (hand protection and less risk to let the fish escape)

€ Estimated costs (€: low, €€: medium, €€€: high)

€€	Human resources: the sampling effort can be significant and therefore costly in terms of time and manpower depending on the parent population and the number of stations monitored
€	Specific service provision for the collection of data and **€€** if external service for the design of a database (DB)
€	Investment / material in the case of a paper format. Significant investment in the first year for the development of the DB tool, then maintenance, but possible mutualisation at national level or between MPAs
€€	Data analysis
€	Sharing data with fishers (or **€€** if service provision)

Administrative procedures, legal provisions

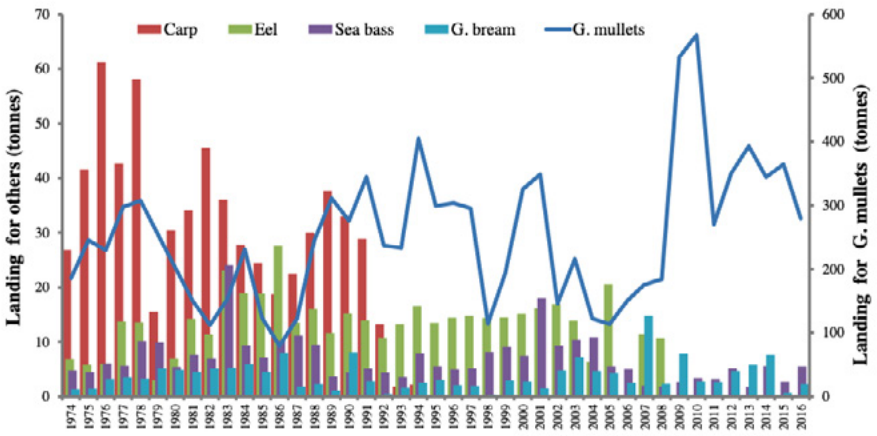
- Declaration of observer boarding to the maritime authorities
- Respect for statistical confidentiality: aggregation of catches from at least 3 vessels per category

Type of results obtained / Metrics

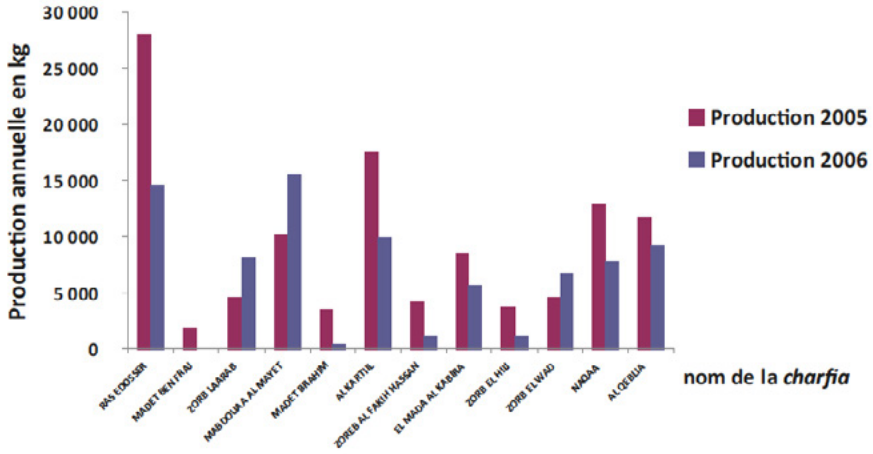
- Basic metrics:
  - number of trips / month, season or year
  - total biomass caught per trip, per fixed station
  - number of shifts worked per trip
  - composition and biomass of catches taken, put back into the fish pen and outside
- Derived metrics:
  - Average CPUE / sector / season or per year
  - CPUE all species total and average, target species / area / day
  - CPUE for one target species (*Sparus aurata*) or a multi-species trade category ('soup', 'sparidae') per area
  - Frequency of occurrence (%) in catches of MPA heritage species (e.g. *Epinephelus spp.*, Elasmobranchs) or lessepsian species

Graphical representations

- Composition of catches harvested, released in and out of the fish pen according to season, year, management area
- Biomass and average CPUE per station, per area, per year



Species landed from the Köyceğiz lagoon from 1974 to 2016. (© Tosunoglu *et al.*, 2018).



Annual production in 2005 and 2006 by charfia in La Chebba (Boughedir *et al.*, 2014)

To go further

- Bonhomme *et al.*, 2011. Suivi des pêcheries de l'étang de Berre – Rapport final. Contrat GIPREB & EI Groupe – GIS Posidonie, Fr : 1-93.
- Boughedir *et al.*, 2014. Les pêcheries fixes artisanales. Etudes de cas : les chrafi de la Chebba. In D. Faget et M. Sternberd (edit), Pêches méditerranéennes – origines et mutation – Protohistoire XXIème siècle. Karthala. 203-222.
- Tosunoglu *et al.*, 2018. Analysis of Long and Short Terms Fishery Landings of Köyceğiz Lagoon (Turkey). Turkish Journal of Fisheries and Aquatic Sciences, 19 (3): 199-208.