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Title

Ecological and economic impacts of marine recreational fishing in France

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Abstract

In 2006, Ifremer, with the help of the polling institute BVA, implemented a national pilot study regarding recreational fisheries. Taking into account all different modes of fishing activities, from seafood gathering to offshore angling, including spear fishing, this study was designed to provide estimates of (i)number of recreational fishers in France, (ii) fishing effort; (iii) catches and landings; (iv) economic impacts of recreational fishing and to draw a classification of recreational fishermen. A dual method survey was adopted: a random-digit-dialing (RDD) survey, combined with an on-site survey. The data collected from telephone and on-site surveys were confronted and used jointly in the final estimations to provide the reliable estimations regarding this growing activity in France. The recreational fishers are estimates around 2.5 millions for a total of captures estimated at 24,000 t of fishes and 3,100 t of shellfishes. The expenditures were also assessed between 1,200 and 2,000 millions euros.

Key-words: Recreational fishing, Catches assessment, Telephone survey, One-site survey

Introduction

Interest in marine recreational fishing has grown in the last three decades, as studies have shown that recreational fishing can be an important source of income for national economies (Haab et al. 2001). Its impact on marine biodiversity is increasingly being recognized as potentially non-negligible, as a large proportion of the catch results in the mortality of the fish caught (Coleman et al. 2004; Lewin et al. 2006). Further, conflicts have developed between recreational fishers and commercial fisheries over the allocation of access to fishing areas and fish stocks (Arlinghaus et al. 2005; Cooke and Cowx 2004; Kerbiriou et al. 2008). Policies aimed at controlling these impacts and reducing these conflicts require a sound information base, which is lacking for recreational activities in most countries around the world (Lee and Chang 2008). Recreational fishing is difficult to monitor due to the diversity of fishing practices involved, and to the fact that the population concerned is often highly mobile (Pollock et al. 1994), on international, national, regional, and local levels. Large-scale information systems for recreational fishing have been developed in several countries, notably the USA (NOAA 2006; Steinback and Gentner 2004), Australia (Henry and Lyle 2003; Gray 2008), New Zealand (Wheeler and Damania 2001), South Africa (Pradervand and Hiseman 2006), and Canada (Analyses économiques et statistiques Secteur des politiques, 2005). In Europe, the UK, Ireland, and Norway (Toivonen et al. 2004) have also been conducting surveys for several years. However, it has recently been recognized that there is still a widespread lack of national data on this activity (ICES 2009). The number of recreational fishers, their total catch, and their total expenditure are known only approximately, if at all, in most European countries. There does not even seem to be an agreed definition of "recreational fishing" at this stage (Pawson et al. 2008). To date, most studies have focused on particular species and areas, and on one type of fishing (Dintheer et al. 2007; Dubreuil 2005; Laspougeas 2007; Lloret et al. 2008; Maggi et al. 1998; Morales-Nin et al. 2005; Peronnet et al. 2003; Pitcher and Hollingworth 2002; Pradervand and Hiseman 2006; Rangel and Erzini 2007; Véron and Appéré 2004). However, there has been increasing social and political interest in this question (Arlinghaus et al. 2007; Drouot et al. 2003), and the need for more comprehensive monitoring systems on the national level has increasingly been recognized (Roth et al. 2001). Recently, the European Commission encouraged its Member Countries to develop the monitoring of recreational

fishing of a limited number of species in the Data Collection Framework (DCF) (International Council for the Exploration of the Sea, 2010).

In France, recreational fishing is subject to only limited regulation; there is no licensing system or registry of marine recreational fishers, and the activity has never been assessed on a national level until the present study. Under the supervision of a national committee, a pilot study was carried out between 2006 and 2009, with the aim of producing a first comprehensive assessment of marine recreational fishing on a national level. The approach drew on methods used in the USA, which combine telephone and on-site surveys (Essig and Holliday 1991; Gentner and Lowther 2002), with some adaptations. In particular, the French survey deliberately addressed the entire spectrum of fishing activities, from shore-based shellfish gathering to boat-based angling, spear-fishing, and the use of nets and traps. The aim of the survey was to provide a first estimate of the number of recreational fishers in France, the number of fishing trips and size of catch, and the economic impact of recreational fishing, and then to establish a typology of recreational fishing activities. This article presents and discusses the methods used in this pilot survey and the main results obtained for Metropolitan France.

Materials and methods

The survey was designed and carried out under the supervision of a national steering committee involving the national administration in charge of fisheries policy (DPMA), scientists working on this topic, and a statistical institute in charge of data collection (BVA), as well as representatives of the main recreational fishing associations and of the French commercial fishing organization. A dual survey was adopted: a random digit dialing (RDD) telephone survey (phase 1) and an on-site survey (phase 2) (Ditton and Hunt 2001; NOAA 2006; Pollock et al. 1994). A similar method had already been used in the USA (Gentner and Lowther 2002), focusing on anglers. The approach was used here for all categories of recreational fishing, including shore-based fish and shellfish gathering. Data collection was carried out over a two-year period. The first phase of the survey was designed to produce an initial estimate of the population of marine recreational fishers at the national level and a basis for the sampling plan of the second phase, using direct interviews, which sought to obtain more precise trip-level data on catch and expenditure. The study was conducted with French residents aged over 15, as

this is the population for which census-based socio-demographic indicators were available. A representative random sample for the RDD survey was selected, which produced an initial estimate of the population of recreational fishers and description of the diversity of their fishing practices. The information collected via telephone surveys also provided a rough estimate of the number of trips, size of catch, and expenditure by fishers, with fairly large levels of uncertainty, as answers were based on recollections of past behavior in relatively short interviews. The on-site surveys were then set up to capture the diversity of fishing practices described in the responses to the telephone survey, with the aim of getting more precise numbers for size of catch and expenditures.

Data collection

First stage of data collection: telephone survey of recreational fishers

A total of 15,000 French households were contacted during the year 2006. The interviews were carried out with the computer-assisted telephone interviewing system (CATI) used by BVA. The interviews were conducted in five waves, in April 2006, June 2006, September 2006, November 2006, and January 2007 (Table 1).

The questionnaire was in five sections (with a maximum of 89 questions), covering (1) marine fishing activity over the previous three months (2006), (2) information about the most recent fishing trip (2006), (3) overall fishing activity during the previous year (2005), (4) information on boats owned (2005), and (6) fishers' perceptions of their activities and how these have changed over time, and their attitudes and opinions about new regulations. It took between 10 and 20 minutes to go through the questionnaire, depending on how many sections were completed by the respondent.

	Survey date	**Number of households interviewed**	**Period of reference for Part A**
	Test stage		
Wave 1	April 2006	2061	January, February, and March 2006
	Study stage		
Wave 2	June 2006	3003	April and May 2006
Wave 3	September 2006	5012	June, July, and August 2006
Wave 4	November 2006	3003	September and October 2006
Wave 5	January 2007	2006	November and December 2006
Total		**15,085**	**1 year = 2006**

Table 1: Distribution of the five waves of the telephone survey in France (overseas territories excluded)

The sampling plan was constructed taking into account the location and socio-demographic characteristics of the households to which the respondents belonged, based on census data for the French metropolitan population aged 15+. The coastal zones were over-sampled based on knowledge derived from previous studies, which showed a greater proportion of recreational fishers in coastal resident populations, with higher numbers of fishing trip and catch levels than those of fishers from inland regions (Morizur 2004). This made it possible to improve the cost-effectiveness of the survey while keeping the sample representative. The selection bias introduced by this over-sampling was adjusted for in the analysis of the information collected, by applying weighting correction factors to the data relating to coastal residents (see below).

Telephone survey data corrections and adjustments

To ensure the sample was representative of the French population, taking into account the over-sampling of coastal residents as well as deviations observed between the socio-demographic characteristics of the sample and the overall population, a set of weighting factors was applied to the sample data. The individual weights were calculated by iterative proportional fitting. This is a procedure implemented by the French National Institute of Statistics and Economic Studies (INSEE), the "Generalized Calibration Procedure" (Macro CALMAR) (Le Guennec and Sautory 2002). The weights were based on the observed characteristics of the household in terms of gender by residence zone (coastal or inland), age by residence zone (coastal or inland), socio-professional group by residence zone (coastal or inland), size of household (coastal or inland), region,[1] and number of interviews carried out during each of the five waves.

The range of final weights applied to individual observations varied between 0.25 and 2.94.

Second data collection stage: on-site survey of fishing trips

The second stage was an intercept survey of recreational fishers at fishing access sites. While the aim of the telephone survey was to estimate the size of the population involved in different types of

[1] As defined by the National Institute of Statistics and Economic Studies.

recreational fishing and to make a preliminary assessment of totals of trip numbers, catch, and landing by recreational fishers in France, it was anticipated that these metrics might be strongly affected by the usual problems of recollection error and response bias described for telephone surveys (NOAA 2006) The on-site survey was thus used as a complement to the telephone survey, to obtain more precise estimates of the key variables relating to catch and expenditure. The sampling plan for the on-site surveys was developed based on the information collected via the telephone survey about the location of interviewees' most recent fishing trip, taking into account the different types of fishing identified in the first phase of the study.

The fishing sites where the surveys were to be conducted were identified by combining different sources of information obtained through the local and national maritime administration, fishing clubs, previous studies (Maggi et al. 1998; Drouot et al. 2003), and experts from IFREMER research laboratories on the coast of Metropolitan France. 150 coastal sites were identified, with each representing a specific type of fishing. The statistical unit for this part of the survey was the fishing trip. Three criteria were used to stratify the sample: the maritime region (Atlantic coast, English Channel, and Mediterranean Sea), the season, and the type of fishing. This led to the identification of 44 strata, of which only 28 were considered for sampling, since fishing activity in the 16 others was considered too limited to be surveyed. For instance, although spear-fishing can be done in the three maritime regions of Metropolitan France all year round, spear-fishers in the Mediterranean were only interviewed during spring and summer, which corresponded to the highest frequency of trips for this type of fishing, according to the telephone survey.

The allocation of sampling effort across strata was based on the distribution of fishing trips per type of fishing across regions and times of the year, as observed in the telephone survey. Some over-sampling was applied to boat fishing and to the winter strata to ensure that a sufficient number of observations would be collected for these categories of trip. By contrast, under-sampling of shellfish gathering was applied, as this was a strongly represented type of fishing for which it was easier to obtain a relatively large sample. As in the telephone survey, these selection biases were accounted for in the analysis of the data collected by applying weighting factors. Angling competitions were excluded from the sampling frame, as they were deemed to introduce bias that would be difficult to measure and correct.

The sample plan of the on-site survey was not randomized, as no sampling frame was available for the scale of fishing trips. Rather, it was developed as a quota-based approach, using the information

collected via the telephone survey to determine the number of observations of fishing trips required per type of fishing (Table 2). This included the description of the most recent fishing trip, which included the type of fishing and the maritime region in which the trip had taken place, and also the number of fishing trips during the previous year along with their distribution across the seasons.

	Number of interviews	Quotas	Result
English Channel			
Shellfish gathering	177	150	118%
Offshore by boat	169	180	94%
Onshore angling	183	190	96%
Total English Channel	**529**	**520**	**102%**
Atlantic			
Shellfish gathering	304	180	168%
Offshore by boat	245	220	111%
Onshore angling	252	180	140%
Total Atlantic	**801**	**580**	**138%**
Mediterranean Sea			
Shellfish gathering	20	20	100%
Offshore by boat	140	140	100%
Onshore angling	197	200	98%
Spear-fishing from shore	45	30	150%
Spear-fishing by boat	63	30	210%
Total Mediterranean Sea	**445**	**400**	**111%**
Total	**1775**	**1500**	**118%**

Table 2: Sampling plan of the on-site survey

Interviewers received initial training in administering the survey and the questionnaire, and were given advice as to the sites to visit and the time of the day at which to visit them. Different types of fishing called for different approaches. When possible, interviews took place on Friday or Saturday (though some took place during the week, for instance at high spring tide dates or school holidays). For the shellfish gathering interviews, agents had to go at low tide. For boat fishing, they visited harbors in late morning and late afternoon, when most of the boats came back. For shore angling, interviewers went to sites known to have a high concentration of fishers (surf-casting beaches, dikes and jetties, etc.). Full questionnaires were administered to fishers only if they had been fishing for at least an hour for shore angling, or 30 minutes for shellfish gathering.

A total of 1775 interviews were carried out between July 2007 and July 2008 (Table 2). Species were identified by the interviewers, who were given training in species identification, but due to logistical constraints and to avoid suspicion on the part of fishers, fish were not directly measured or photographed. Interviewers had to estimate the weight and length of fish caught by visual observation.

The questionnaire for the on-site survey was based on the design used in the telephone survey, and consisted of a maximum of 81 questions, focusing mainly on the current fishing trip of the fishers interviewed.

Lastly, the data from the telephone survey were also sorted by fishing trip (Robson and Jones 1989). Each fisher received a weight proportional to the annual number of fishing trips taken.

Extrapolation methods

Appraisal of the number of recreational fishers

To estimate the number of recreational fishers in France, four steps were required. The calculation can be summarized in this formula:

(Number of recreational fishers in 2005 in our sample/ Number of people over 15 in our sample) x French population over 15 = Estimate of the number of recreational fishers

Calculation of size of catch

The two surveys were combined to obtain a first estimate of total catch per species and per group of species. The telephone survey data were considered as equivalent to 3130 fishing trips, weighted to give a representative sample of the total number of fishing trips for the year 2005. Extrapolation from the number of fishing trips and the number of fish landed per trip was used to extrapolate the total catch per species and per type of fishing. The calculations are detailed below.

$$N + N' = T$$

N = Weighted number of fishing trips in the telephone survey (after data adjustment)
N' = Weighted number of fishing trips in the on-site survey (after data adjustment)
T = Total weighted number of fishing trips

$$\sum_{E,M} n_{E,M} + \sum_{E,M} n'_{E,M} = SP \quad \text{and} \quad TP = \frac{SP}{T}$$

$n_{E,M}$ = number of fishing trips with catch for the species E and the type of fishing M in the telephone survey
$n'_{E,M}$ = number of fishing trips with catch for the species E and the type of fishing M in the on-site survey
SP = total number of fishing trips with catch
TP = catch ratio per fishing trip

For the fishing trips with catch we calculated (with the information from both surveys):

$$PU_i = \frac{KG_i}{PR_i}$$

PR_i = number of fish per fishing trip *i*

KG_i = total weight of catch per fishing trip *i*

PU_i = average weight per fish per fishing trip *i*

w_i = weighting factor for the fishing trip *i*

$$PU = \frac{\sum_i PU_i}{SP} \quad \text{and} \quad PR = \frac{\sum_i PR_i}{SP} \text{ and } PT = PU \times PR$$

PU = average weight per fish
PR = average number of fish per fishing trip with catch
PT = total weight per fishing trip with catch

The previous calculations were also done by species and by type of fishing, and were notated as PR_E, PR_M, $PR_{E,M}$ ... These detailed calculations were done for each type of fishing, but only for species for which the number of observations was sufficiently high.

We wanted to calculate the extrapolated number of fishing trips in 2005. This extrapolation was made from telephone survey data only, with the same extrapolation method as for the calculation of the number of recreational fishers in 2005.

$$TOTAL_{MwithC} = TOTAL_M \times TP$$

$TOTAL_M$ = Extrapolated number of fishing trips of type of fishing M = Estimate of the total number of fishing trips for 2005

$TOTAL_{MwithC}$ = Estimate of the total number of fishing trips with catch for 2005

Finally, the total catch was estimated by type of fishing and/or by species:

$$W_M = TOTAL_{MwithC} \times PT$$

W_M = estimation of the total catch for the type of fishing M in 2005

Aggregation across the telephone and on-site survey data was based on the confidence interval, regarding each group of species: The higher the standard error of the estimate derived from the

telephone survey by comparison with the estimate derived from the on-site survey, the lower the weight of the estimate derived from the telephone survey in the final estimate.

Calculation of expenditure

The calculation of costs was based on responses to three groups of questions:

- the description of the most recent fishing trip, regarding both time budgets (preparation, travel, fishing time) and expenses specific to each trip (travel costs, food costs, fees, gasoline for boat trips, etc.), defined as operating costs
- the costs of equipment and clothing for the activity, defined as investment costs
- the costs related to depreciation and maintenance of boats, defined as costs for boats.

Extrapolations based on the sample data were carried out as follows:

- First, we estimated the total number of fishers and calculated total investment costs.
- Second, we estimated the total number of vessel owners and calculated the total costs for boats, which were then weighted by the rate of use of boats for fishing that were declared by respondents (fishing trips as a percentage of total trips made with the boat).
- Third, we estimated the average number of fishing trips per fisher and calculated the overall budget-related operating costs.

Data from both telephone and on-site surveys were used: 67% from phone and 33% from on-site surveys.

The economic results are obtained from a series of calculations based on five variables: number of fishers (X_1), number of trips per fisher (X_2), total expense per trip (X_3), number of boats (X_4), average expenditure per boat (X_5).

The total amount of expenditure is expressed as $D = X_1 X_2 X_3 + X_4 X_5$ and the variance of D is

$V(D) = V(X_1 X_2 X_3) + V(X_4 X_5)$.[2]

Results

[2] We assume the independence of these five variables. This simplifying assumption is not too restrictive, since these estimates are based on entirely different calculation methods. Taking into account correlations between variables increases the calculations considerably; we can then show that these effects are second-order, using the same reasoning as in the formula above.

In this section, we present the key results obtained for Metropolitan France.

Recreational fisher population

In 2005, the penetration rate (the number of fishers in the sample) was 11.1% in the coastal zone and 5.4% in the inland zone, representing 6.7% of the total interviewed households for 2005. The number of recreational fishers aged 15+ in the sample was 1,016 (1.57 fishers per household). The total number of recreational fishers aged 15+ in Metropolitan France was estimated at 2.45 million (+/- 0.15 million) in 2005, representing 5.1% of the population.

Statistically significant differences in the socio-demographic profile were observed between recreational fishers and the average characteristics of the French population. There was a greater proportion of males (82%) and of individuals aged between 35 and 49. As expected, recreational fishing was represented twice as much in coastal area households as in the rest of the country (Table 3).

	French population over 15	**Recreational fishers (after adjustment)**
Sex		
Men	48%	**82%***
Women	52%	**18%***
Age		
15-24	16%	**4%***
25-34	17%	**21%***
35-49	27%	**38%***
50-64	20%	**25%***
65 and over	20%	**12%***
Profession		
Farmer	2%	**1%**
Craft worker, Shopkeeper	17%	**18%***
Executive	14%	**21%***
Employee	10%	**13%***
Laborer	23%	**21%***
Retired or other inactive	34%	**26%***

Table 3: Comparison between the characteristics of the French population over 15 and the characteristics of the recreational fishers in the sample, after adjustment
*= significant difference at 5% (chi-square test)

Recreational fishing effort

The average number of trips per year per fisher was 13 in 2005. Half of them occurred during summer (Figure 1), the period of better weather conditions and the school summer vacation, which is associated with a large influx of visitors to the coastal areas of France.

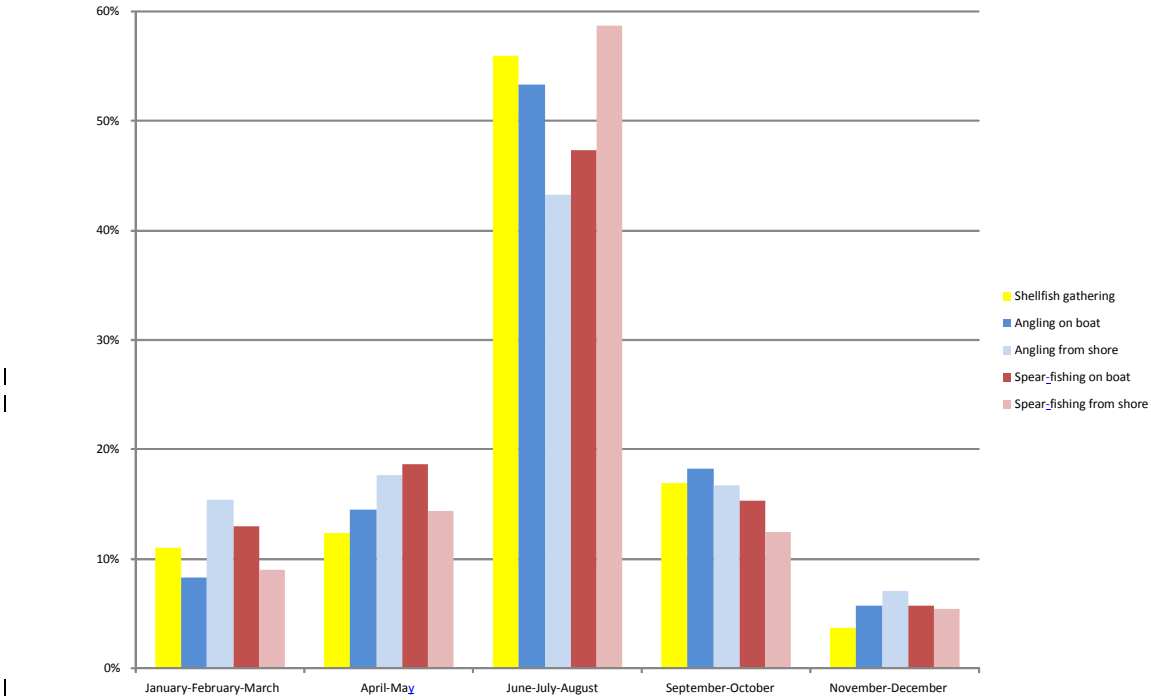


Figure 1: Distribution of fishing trips during 2005 (telephone survey data)

In 2005, the average number of types of fishing was 1.4 per fisher. Recreational fishers mainly practiced shellfish gathering (71%); 25% practiced angling from boats (Figure 2). Spear-fishing represented only a very small proportion of marine recreational fishing. 14% of the interviewed fishers owned a boat used for this activity. The total was estimated at 335,000 boats.

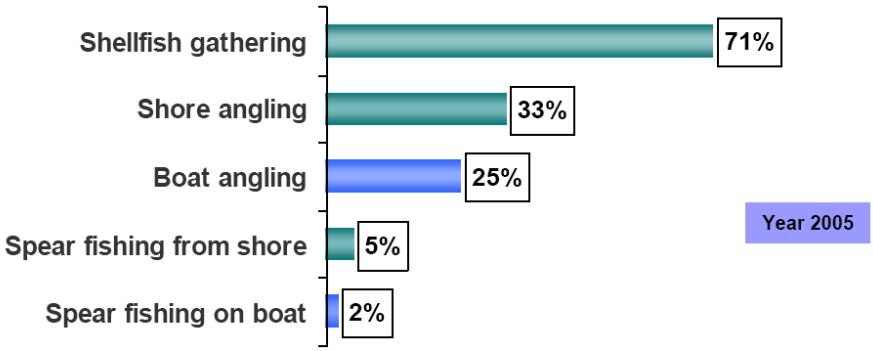


Figure 2: Distribution of types of fishing for fishers with at least one fishing trip in 2005 (telephone survey data).

Two-thirds of the fishers interviewed caught at least one shellfish during the year, 55% at least one fish, 51% at least one crustacean, and 12% at least one cephalopod.

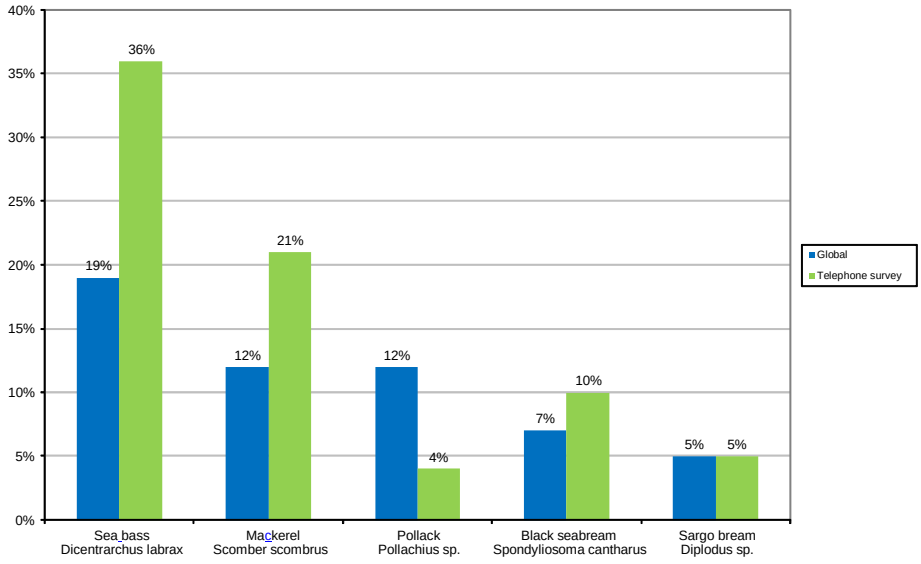


Figure 3: Proportion of the main species in the catch declaration: telephone survey estimate and final (telephone + on-site survey) estimate

We detail total fish catch by type of fishing and by species, highlighting the confidence interval (Table 4).

Species name (common)	Spear-fishing from shore	Spear-fishing from boat	Angling from shore	Shellfish gathering	Angling from boat	Total weight	Confidence interval
Abalone	-	-	-	18	-	18	86
Anchovy	-	-	20	-	0	20	57
Atlantic horse mackerel	-	-	1	-	22	23	54
Black seabream	86	0	588	118	1 273	2 065	962
Bogue	-	-	8	-	2	10	38
Bonito	-	-	7	-	75	81	261
Brown comber	-	-	17	-	51	68	171
Brown trout	-	-	-	30	-	30	302
Carp	-	-	104	21	-	125	410
Clam	-	-	50	564	1	614	368
Cockle	0	-	7	480	-	486	333
Cod	-	-	71	-	308	379	574
Common dab	-	-	0	-	138	139	309
Common prawn	-	-	61	71	0	132	120
Common seabream	-	-	-	-	31	31	154
Conger	-	6	296	17	454	773	806

Crab (edible + spider)	-	42	66	1002	197	1 207	972
Cuttlefish	-	7	1	1	99	107	4
Derbio	-	-	2	-	-	2	12
Donax	-	-	-	16	-	16	345
Eel	-	-	969	13	-	981	1 075
Flounder	-	-	1	17	0	18	171
Garfish	-	-	25	-	153	177	246
Gilthead	-	-	23	41	73	137	184
Goby	-	-	7	1	55	63	140
Gray triggerfish	-	-	0	-	7	7	26
Great Atlantic scallop	19	27	-	8	-	54	174
Greater sand eel	-	-	-	1	0	1	3
Grey mullet	5	5	125	48	44	227	264
Grouper	-	-	814	-	-	814	1 036
Hake	-	-	-	-	97	97	250
Hermit crab	-	-	-	1	-	1	2
Lesser grey mullet	75	1	17	-	95	188	448
Limpet	-	-	-	28	-	28	47
Lobster	10	-	-	-	1	11	51
Mackerel	0	165	193	103	3 174	3 635	1 575
Meagre	-	-	2	16	576	594	860
Moray	-	-	26	-	0	26	76
Mussel	3	-	33	419	-	455	308
Norway lobster	-	-	-	2	-	2	17
Oblade	-	-	35	-	8	43	79
Octopus	5	0	1	74	10	160	991
Oyster	-	-	-	1 201	0	1 201	1 052
Plaice	-	62	48	42	71	223	483
Pollack	-	2	366	0	3 161	3 529	2 515
Pout	-	-	85	-	99	184	-
Queen scallop	-	-	-	3	-	3	14
Rainbow wrasse	26	-	29	0	55	110	178
Ray	-	-	1	-	19	19	138
Red gurnard	-	-	-	-	17	17	74
Red mullet	-	-	-	1	1	1	54
Sand steenbras	-	-	0	-	37	37	75
Sardine	-	-	169	-	2	170	1
Saupe	3	-	30	-	0	33	624
Scorpion fish	19	-	47	-	56	122	55
Sea bass	115	24	1 775	690	3 009	5 612	1 964
Sea urchin	0	0	0	116	-	116	183
Sebaste	-	-	-	-	1	1	50
Sergeant major	9	-	-	-	4	13	31
Shark	-	-	14	0	33	48	199
Smelt	-	-	26	2	0	29	45
Sole	0	70	150	1	236	457	138
Solen	-	-	5	49	-	54	76
Sprat	-	-	25	-	-	25	610
Squid	-	0	43	-	185	228	482
Surmullet	0	1	7	-	12	19	91
Tuna	-	-	-	5	53	57	45
Turbot	-	-	-	-	22	22	94
Velvet crab	-	-	82	139	9	230	281
Whelk	-	1	-	50	-	51	73
Winkle	-	-	15	76	-	91	74

Whiting	-	-	10	-	57	67	189
White bream	30	53	401	-	256	840	168
Warty venus	-	-	-	77	1	77	261
Worm	-	-	-	11	0	11	80
Weever	-	-	0	0	342	342	69

Table 4: Weight of species catch in tonnes and by type of fishing (highlighted species are those for which the confidence interval is lower than the estimate and the estimate can thus be considered sound)

Average catch of fish per fisher was 10 kg per year^{-1} (Table 5). The most sought-after species were sea bass (19% of fishers), mackerel (12%), and pollack (12%). The proportion of the three main species in total catch decreased from 67% to 43% when the two surveys were combined, as the on-site survey provided details of catch for species that had not been captured in the telephone survey. Rarer and less targeted species were observed and counted on-site, whereas they were often forgotten by fishers in the RDD declarations (Figure 3). This led to a final estimate of total catch of fish (Table 4) that was higher in the combined survey results than in the telephone survey only. Conversely, for other species groups (crustaceans, cephalopods, and shellfish), estimates of total catch were lower in the combined survey results, as it appears that fishers over-estimated their catch in weight of these species in the telephone survey. The differences between the two estimates showed the advantage of combining the two survey approaches to get more accurate results (Weithman and Haverland 1991).

	Initial estimate Telephone data	**Final estimate** Telephone + on-site data
Fish		
Overall catch (tonnes)	14,500 T (+/- 5000)	24,500 T (+/- 4600)
Average weight per year per fisher (>15 years old)	6.1 kg +/- 2.1	10.0 kg +/- 1.9
Sea bass (*Dicentrarchus labrax*)	5000 T (+/- 1200)	5600 T (+/- 1600)
Mackerel (*Scomber scombrus*)	3300 T (+/- 100)	3600 T (+/- 1600)
Gilthead (*Spratus aurata*)	1600 T (+/- 500)	2000 T (+/- 960)
Pollack (*Pollachius pollachius*)	nc*	3500 T (+/- 2500)
Shellfish		
Overall catch (tonnes)	13,500 T (+/- 2500)	3150 T (+/- 1 200)
Average weight per year per fisher (>15 years old)	3.5 kg +/- 1.3	1.3 kg +/- 0.5
Mussels (Mytilidae)	4300 T (+/- 1200)	460 T (+/- 300)
Oysters (Ostreidae)	3000 T (+/- 900)	1200 T (+/- 1000)
Common cockles (Cardiidae)	2500 T (+/- 800)	490 T (+/- 300)
Carpet shells (Veneridae)	2300 T (+/- 700)	600 T (+/- 400)
Crustaceans		
Overall catch (tonnes)	6700 T (+/- 2600)	1600 T (+/- 900)
Average weight per year per fisher (>15 years old)	2.8 kg +/- 1.1	0.7 kg +/- 0.4
Cephalopods		
Overall catch (tonnes)	1600 T (+/- 500)	495 T (+/- 600)
Average weight per year per fisher (>15 years old)	0.7 kg +/- 0.2	0.2 kg +/- 0.3

Table 5: Catch estimates: comparison of the results from the telephone survey and the results from the combination of the two surveys. The confidence intervals for the estimates are indicated in parentheses.
nc*= not enough data to calculate the total catch

Final results estimated the fish catch at about 24,500 T, shellfish about 3150 T, crustaceans about 1600 T, and cephalopods about 495 T (Table 6). Fish catch was split into two categories. The first included the five main species cited as target species, and represented approximately 15,500 T in total. For these species, estimates obtained from the telephone survey and estimates obtained from combining the telephone and on-site surveys were remarkably similar. It thus appears that for these species at least, the information obtained via telephone surveys was fairly reliable. The second category included all other fish species caught, for which the evaluation was less accurate and the confidence interval too high to make sense at the species level.

	Angling from shore	Angling from boat	Shellfish gathering	Spear-fishing from boat	Spear-fishing from shore	Total
Fish						
Tonnes	7460	14,453	1386	406	621	**24,325**
ME*	+/- 2481	+/- 3653	+/- 800	+/- 646	+/- 667	**+/- 4583**
CV**	0.33	0.25	0.58	1.59	1.07	**0.19**
Shellfish						
Tonnes	109	2	2990	28	22	**3152**
ME	+/- 143	+/- 19	+/- 1216	+/- 91	+/- 141	**+/- 1235**
CV	1.31	9.01	0.41	3.20	6.37	**0.39**
Crustaceans						
Tonnes	209	206	1146	42	10	**1613**
ME	+/- 335	+/- 280	+/- 686	+/- 232	+/- 50	**+/- 847**
CV	1.60	1.36	0.60	5.53	4.87	**0.53**
Cephalopods						
Tonnes	44	294	74	7	75	**495**
ME*	+/- 197	+/- 473	+/- 199	+/- 27	+/- 162	**+/- 574**
CV**	4.42	1.61	2.69	3.79	2.16	**1.16**
Invertebrates						
Tonnes	-	0	11	-	-	**11**
ME		+/- 3	+/- 69			**+/- 69**
CV		30.72	6.28			**6.23**
Sea urchins						
Tonnes	0	-	116	0	0	**116**
ME	+/- 1		+/- 182	+/- 2	+/- 16	**+/- 183**
CV	33.36		1.58	41.86	44.16	**1.58**
Total						
Tonnes	**7824**	**14,956**	**5723**	**483**	**728**	**29,714**
ME	**+/- 2 515**	**+/- 3694**	**+/- 1633**	**+/- 693**	**+/- 703**	**+/- 4859**
CV	**0.32**	**0.25**	**0.29**	**1.43**	**0.97**	**0.16**

Table 6: Final catch estimates (telephone + on-site data) per type of fishing
* ME = Margin of error and **CV = Coefficient of variation

Estimates of expenditure

Estimates of total expenditure were made for the three categories of costs identified in the survey:

1. Operating costs including the costs of transport, food and lodging specific to each trip (Figure 4a):

- The average car transport cost was 3.20 € per trip per person.
- The average boat transport cost was 1.64 € per trip per person.
- The average food cost was about 23 € per trip with expenses. This expense concerned 42.2% of fishing trips. The average food cost was 9.72 € per trip per person.
- The average accommodation cost was about 339.74 € per stay. Dividing this by the number of fishing trips made during the stay, the accommodation cost per trip per person is estimated at 28.74 €. This expense concerned 7.6% of fishing trips. The average accommodation cost was 2.19 € per trip per person.

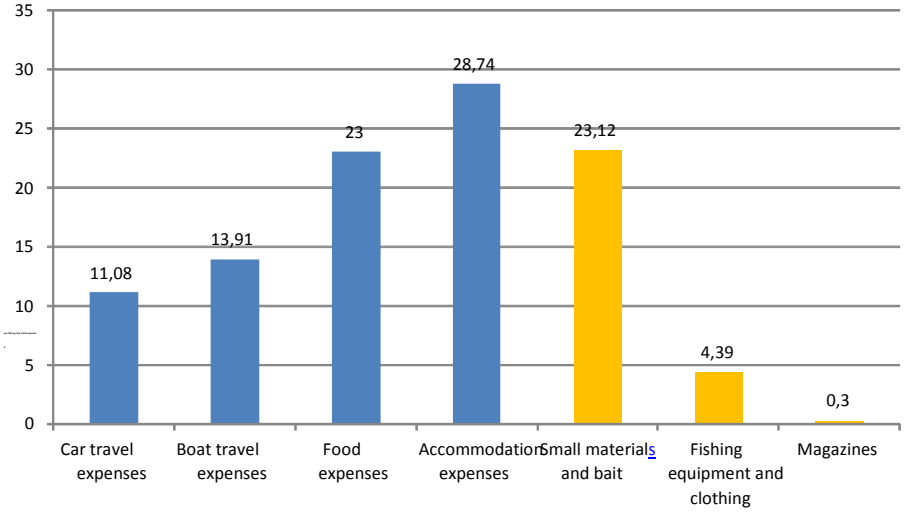
2. Investment costs include the cost of practicing recreational fishing (bait, material, equipment, clothes, magazines, etc.) (Figure 4a):

- Small equipment and bait cost was on average 23.12 € per trip with expenses. This expense concerned 44% of fishing trips. The average cost was 10.22 € for the total number of trips.
- Fishing equipment (rods, reels, nets, etc.) and clothing costs were estimated at 4.39 € per trip with expenses and concerned 79% of trips. The average cost was 3.48 € for the total number of trips.
- Expenses for specialized magazines were estimated at 0.30 € and concerned 74% of the trips. The average magazine cost was 0.22 € for the total number of trips.

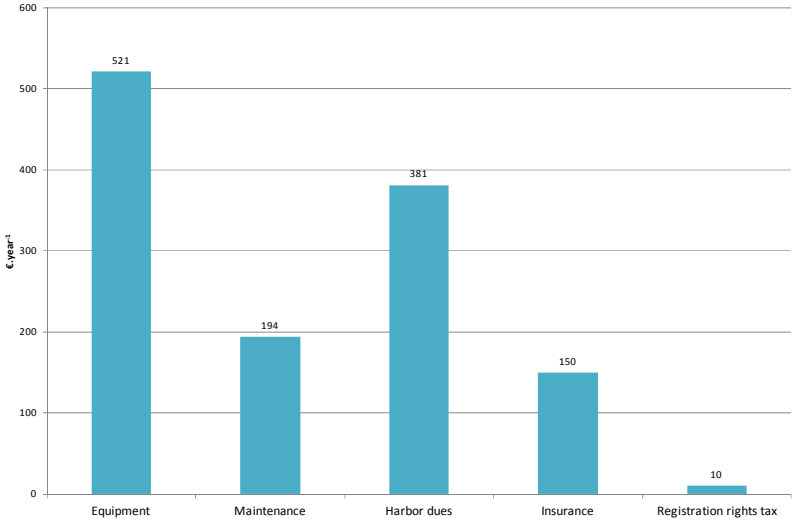
3. Costs relative to the boat include the depreciation and use of boats (maintenance, insurance, etc.) (Figure 4):

- The average boat purchase price was 24,931 €. 81% of the fishers had bought a boat. The calculation of depreciation (basis over 30 years) gave an average of 545 € per year^{-1}.
- The average annual cost for the use of boats was divided into several categories: average equipment expenditure= 521 €; maintenance=194 €; harbor dues= 381 €; insurance= 150 €; registration rights tax= 10 €. The total cost for the use of each boat was estimated at 1256 €,

with 61% of the trips made in the boat being related to recreational fishing. The average cost for the use of a boat for recreational fishing was thus estimated at 766 € per year^{-1}.



(a)



(b)

Figure 4: Average costs: (a) operating and investment costs per fishing trip with expenses and (b) costs related to ownership and use of boat for recreational fishing per year

Total costs were calculated using the five variables listed in the methods section (Table 7).

Code	Variable	Mean	CV*
X1	Number of fishers	2,450,000	3.1%
X2	Number of trips per fisher	12.77	9.6%
X3	Total expense per trip (mean of operating cost per trip + mean of investment cost per trip)	30.67	9.3%
X4	Number of boats	234,954	1.0%
X5	Average expenditure per boat	1311	34.3%

Table 7: Variable assessment for the calculation of total expenditure:
*Coefficient of variation

The extrapolation of annual expenditures generated by recreational fishing, based on a combination of the data collected by telephone and the on-site surveys, was 1.256 billion euros, divided among operating expenditures (524 M€), investment expenditures (435 M€), and expenditures on boats (308 M€) (Figure 5). The standard deviation of expenditure is 221,359,471 €, representing a coefficient of variation of 17.5% (222 M€/1267 M€). The total expenditure is estimated with a relative error of 2*17.5% = 35%.

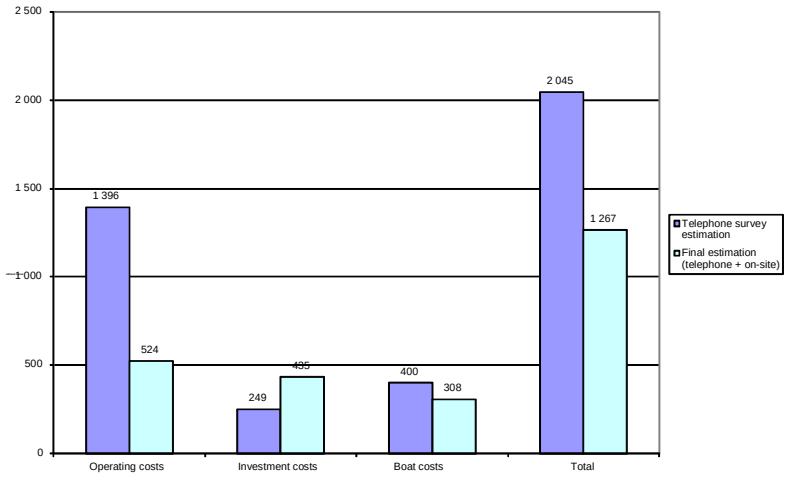


Figure 5: Total expenditure estimates for 2005, comparison of telephone survey estimates and overall estimates

As in the case of catch figures, this estimate of expenditures was compared to an estimate based on telephone survey data alone. After the two surveys were combined, the final estimate of expenditures represented 61% of the estimate derived from the telephone survey database alone.

Discussion

Our results provide a benchmark from which it will be possible to monitor social, economic, and ecological trends in recreational fishing in subsequent years. In particular, we have developed a set of statistics that should make for more constructive discussion between commercial and recreational fishers, and help to mediate conflicts over shared resources (Arlinghaus 2005; Cooke and Cowx 2006). It is crucial to be able to identify potential sources of conflict and possibly to manage and control them. Without data and indicators, conflicts will increase.

The size of the recreational fishing catch is around 2% of the commercial catch in France and 11% of the commercial fresh (not frozen) landing. Even if the total catch of recreational fishing is low compared to commercial fishing, the catch of some targeted species can be considered high, especially sea bass (around 100% of that of commercial landing), mackerel (19%), gilthead and black seabream (44%), and pollack (92%). In addition, mackerel and pollack are subject to the European Commission TAC (Total Allowable Catch): mackerel catch from recreational fishing represents one-third of the permitted French quota for this species. For the moment catch by recreational fishers is not counted in the quota.

However, these figures must be used with caution since data collection methods are quite dissimilar.

The estimate of transport expenses (by boat or car) is robust (using mileage and number of liters consumed). The investment and boat costs are also accurately measured, but display high variability in correlation with variability in types of boat. This diversity leads to less precision and greater standard error. The food and lodging expenditures are more difficult to estimate. The variability of the data is very great, and it is sometimes difficult to identify the part of these expenditures actually imputable to recreational fishing (especially when it is included in a vacation). The estimates of total expenditure must thus be viewed with caution. A methodological improvement might be to ask recreational fishers what are their additional costs for food and housinf on these trips.

While statistical results are an interesting topic, the main part of the discussion concerns methodological outputs.

Gathering national statistics on recreational fishing is becoming more and more mandatory, prompted by the increase of this activity and its hypothetical impact.

However, as with all leisure and tourism activities, it is very hard to monitor recreational fishing because the population of recreational fishers is mobile and highly heterogeneous. It is thus necessary to test and improve new methodologies step by step, with a learning-by-doing approach. This French pilot study was interesting to test, and identified the strengths and limits of a dual methodology using telephone and on-site surveys.

The study has made it possible to define a benchmark that we will need for systematic follow-up of recreational fishing. It has three dimensions:

- Species: this was developed using the data from the telephone survey, complemented by the on-site survey. It can be improved further, and is linked with the French national Fisheries Information System (website: www.ifremer.fr/sih).
- Types of fishing: this already seems quite complete, as nearly all recreational fishing practices are indexed. It would be useful to connect this information with the “métier classification” used for commercial fishers (Daurès et al. 2009).
- Recreational fishing sites: this was developed using several data sets in combination drawn from other studies, administration, local knowledge, and so on. Now we need to build a more précis site-period matrix on each seaboard, in order to establish a reference state from which the sample plan can be developed.

The RDD survey is a cost-effective method that gives a good estimate of the proportion of the French population that practices recreational fishing as well as information about recreational fisher profiles (Gentner and Lowther 2002). The off-site survey also provides good coverage of night and private-access fishing that is typically difficult to assess using on-site surveys. However, data about catch and expenditure are not precise enough. It is hard for recreational fishers to recall the total weight of their catch during 2005. A year later than the events is certainly too long a delay, and the unreliable memory of respondents introduces bias (Essig and Holliday 1991).

On-site surveys are very expensive and cross-referencing the RDD and on-site data is far from easy, though it does give better information about catch details, especially for the estimates of shellfish and crustacean catch. Reliable, more detailed data about these have been obtained via intercept surveys, where we had direct observation (Drouot et al. 2003; Pollock et al. 1994).

The sharp differences between the results of the telephone survey and the combination of surveys are essentially due to errors on declared weights by individuals interviewed by telephone (Tarrant et al. 1993). This is especially true for shellfish and crustacean species for which those interviewed seem to be unable to assess the weight of their catch precisely (they overestimate). In France, it is normal to measure shellfish in liters, but in the telephone survey they were asked to use kilograms.

The difference between the reported weights of fish is due to the fact that the diversity of fish species is lower in the phone responses than in the on-site survey. Reports of non-targeted fish species were

absent. By telephone, anglers only reported the most common species and larger fish actually caught and not discarded (Essig and Holliday 1991).

However, by cross-referencing the data from both surveys, we get a much better estimate of the total catch for the main species. One limitation of this method is that the data from both surveys are not numerous enough to provide a precise estimate of the catch of the less targeted species. The number of observations of those rare species is too low to allow for extrapolation.

Additional biases in both telephone and on-site surveys can be noted:

The telephone survey reached occasional fishers more easily than the on-site survey, because they come to fish less frequently. In this population, probably less used to assessing the volume and weight of their catch, we observe a substantial difference between phone responses and observation by on-site survey.

The telephone survey also samples households, hence individuals, whereas the on-site survey samples fishing trips. In order to combine the two databases we have used one statistical unit, the individual trip.

Another bias of the telephone survey that is difficult to correct is that a (low) percentage of households has no home telephone. These may represent special categories (those with only a cell phone, those who move a lot, those without access to a telephone, etc.) that are undercounted.

But the on-site survey also displays bias: both the avid fishers and the very occasional fishers are undercounted (Dauk and Schwarz 2001). The first group prefers sites that are not accessible or not known to other fishers or interviewers. The second group is not often present, so their proportion in the on-site sample is lower.

Conclusion

This study provides a first comprehensive view of recreational fishing in France, covering all types of fishing. The most common type is definitely shellfish gathering. However, the volume involved is small, as most fishers make only one or two fishing trips a year. Shellfish gathering is an occasional and low-intensity activity; nonetheless, angling on shore and from boats accounts for 24,500 tonnes of fish annually.

This new information has substantial importance for improving the governance of marine social-ecological systems. It is now more and more mandatory to produce national statistics on recreational fishing, due to the increase in this activity and its presumed impact. It is a genuinely new research topic, and it is thus necessary to test and improve new methodologies step by step, using a learning-by-doing approach. This pilot study in France was interesting to test, and has identified the strengths and limits of a methodology using both telephone and on-site surveys. We have noted that on-site surveys have some drawbacks. They are difficult to implement and very expensive, and do not eliminate all the biases of telephone surveys. Also, combining the telephone and on-site data is far from easy; it is thus important to go on to test alternative monitoring systems, such as the use of a voluntary recreational fishers logbook.

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Bibliography

Analyses économiques et statistiques Secteur des politiques (2005). *Enquête sur la pêche récréative au Canada*, Analyses économiques et statistiques, Secteur des politiques Pêches et Océans Canada. Pêche et Océan Canada, 58p.

Arlinghaus, R. (2005). A conceptual framework to identify and understand conflicts in recreational fisheries systems, with implications for sustainable management. *Aquatic Resources, Culture and Development,* **1:**145-174.

Arlinghaus, R., Cooke, S. J., Schwab, A. and Cowx, I. G. (2007). Fish welfare: a challenge to the feelings-based approach, with implications for recreational fishing. *Fish and Fisheries,* **8:**57-71.

Arlinghaus, R., Cooke, S. J., Coleman, F. C., Figueira, W. F., Ueland, J. S. and Crowder, L. B. (2005). Global Impact of Recreational Fisheries. *Science,* **307:**1561-1563.

Coleman, F. C., Figueira, W. F., Ueland, J. S. and Crowder, L. B. (2004). The impact of United States recreational fisheries on marine fish populations. *Science,* **305:** 1958-1960.

Cooke, S. J. and Cowx, I. G. (2006). Contrasting recreational and commercial fishing: Searching for common issues to promote unified conservation of fisheries resources and aquatic environments. *Biological Conservation,* **128:**93-108.

Cooke, S. J. and Cowx, I. G. (2004). The role of recreational fishing in global fish crises. *Bioscience,* **54:**857-859.

Dauk, P. C. and Schwarz, C. J. (2001). Catch Estimation with Restricted Randomization in the Effort Survey. *Biometrics,* **57:**461-468.

Daurès, F., Rochet, M.-J., Van Iseghem, S. and Trenkel, V. M. (2009). Fishing fleet typology, economic dependence, and species landing profiles of the French fleets in the Bay of Biscay, 2000-2006. *Aquatic Living Resources,* **22:**535-547.

Dintheer, C., Herfaut, J., Thébaud, O., Sénac, S., Tranger, H. and Le Guen, C. (2007). La pêche de loisir en mer au cabillaud sur la façade septentrionale de la France (Manche - Mer du Nord, zones CIEM VIIed et IVc). *Rapport de l'étude pilote menée dans le cadre du réglement CE n°1584/2004.* Programme français DCR 2006, Ifremer, BVA.

Ditton, R. B. and Hunt, K. M. (2001). Combining creel intercept and mail survey methods to understand the human dimensions of local freshwater fisheries. *Fisheries Management and Ecology,* **8**: 295-301.

Drouot, B., Daurès, F., Guyader, O. and Lesueur, M. (2003). An economic evaluation of the recreational fishing on foot in the Gulf of Morbihan (Brittany, France). *Fifteenth annual conference of European Association of Fisheries Economists (EAFE,2003) Session 9.3.*, Acte de colloque Ifremer.

Dubreuil, J. (2005). Caractérisation de la pêche de loisir dans la région de Banyuls-sur-Mer (NO Méditerranée) : typologie, "effet réserve" et perspectives. *Rapport de Master Pro.* Université de Perpignan.

Essig, R. J. and Holliday, M. C. (1991). Development of a recreational fishing survey: the marine recreational fishery statistics survey case study. *American Fisheries Society Symposium,* **12:**245-254.

Gentner, B. and Lowther, A. (2002). Evaluating Marine Sport Fisheries in the USA. *Fish and Aquatic Resources Series,* **8:**186-205.

Gray, C. (2008). Management and assessment of the recreational fisheries in NSW: An overview. *Australian Society for Fish Biology Workshop and Conference.* Sydney, Australia.

Haab, T. C., Whitehead, J. C. and McConnell, T. (2001). The economic value of marine recreational fishing in the Southeast United Stades, 1997, Southeast economic data analysis, Technical Memorandum. NOAA, National Marine Fisheries Service.

Henry, G. W. and Lyle, J. M. (2003). The National Recreational and Indigenous Fishing Survey. Australian Government Department of Agriculture, Fisheries and Forestry.

ICES (2009). Report of the workshop on Sampling Methods for Recreational Fisheries (WKSMRF). IN 20009, I. C. (Ed.) Nantes.

International Council for the exploration of the Sea (ICES) (2010). *Report of the Planning Group on Recreational Fisheries Surveys (PGRFS)*, 7-11 June 2010, Bergen, Norway, 192 pp.

Kerbiriou, C., Leviol, I., Jiguet, F. and Julliard, R. (2008). The impact of human frequentation on coastal vegetation in a biosphere reserve. *Journal of Environmental Management,* **88:**715-728.

Laspougeas, C. (2007). Etude des gisements naturels de mollusques bivalves accessibles en pêche à pied en Basse-Normandie. Université de Caen.

Le Guennec, J. and Sautory, O. (2002). Calmar 2 : une nouvelle version de la macro calmar de redressement d'échantillon par calage. *Insee-Méthodes : Actes des Journées de Méthodologie Statistique 2002.* INSEE.

Lee, C. C. and Chang, C. P. (2008). Tourism development and economic growth: A closer look at panels. *Tourism Management,* **29:**180-192.

Lewin, W.-C., Arlinghaus, R. and Mehner, T. (2006). Documented and Potential Biological Impacts of Recreational Fishing: Insights for Management and Conservation. *Fisheries Science,* **14:**305-367.

Lloret, J., Zaragoza, N., Caballero, D. and Riera, V. (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.

Maggi, P., Chapron, V. and Ratiskol, G. (1998). Evaluation de la fréquentation des zones de pêche récréative durant des grandes marées de 1997, Résultats des campagnes menées sur le littoral compris entre la baie du Mont-Saint-Michel (Ille-et-Vilaine) et la Pointe de Châtelaillon (Charente-Maritime). Ifremer Laboratoire côtier DEL de Nantes.

Morales-Nin, B., Moranta, J., Garcia, C., Tugores, M. P., Grau, A. M., Riera, F. and Cerda, M. (2005). The recreational fishery off Majorca Island (western Mediterranean): some implications for coastal resource management. *ICES Journal of Marine Sciences,* **62:**727-739.

Morizur, Y. (2004). Sondage national sur pêches récréatives (dont celle du bar) réalisé par BVA en 2003. Ifremer.

NOAA (2006). Review of recreational fisheries survey methods. National Academies Press of Washington.

Pawson, M. G., Glenn, H. and Padda, G. (2008). The definition of marine recreational fishing in Europe. *Marine Policy,* **32:**339-350.

Pawson, M. G., Tingley, D., Padda, G. and Glenn, H. (2004). Final Report: EU contract FISH/2004/011 on “Sport Fisheries” (or Marine Recreational Fisheries) in the EU for The European Commission Directorate-General for Fisheries. EC Directorate-General for Fisheries Sport Fishing C2362 Unit FISH-1.

Peronnet, I., Talidec, C., Daurès, F., Guyader, O., Drouot, B., Boude, J.-P. and Lesueur, M. (2003). Etude des activités de pêche dans le golfe du Morbihan –Partie 2 : Pêche de loisir, Schéma de Mise en Valeur de la Mer du golfe du Morbihan. Ifremer.

Pitcher, T. J. and C. Hollingworth (2002). Recreational Fisheries, Ecological, Economic and Social Evaluation. Fish and aquatic resources series 8, Blackwell Science. 271 pp.

Pollock, K. H., Jones, C. M. and Brown, T. L. (1994). Anglers' survey methods and their application in fisheries management. *American Fisheries Society Special Publications,* **25:**378-380.

Pradervand, P. and Hiseman, R. (2006). An analysis of the recreational shore fishery in the Goukamma Marine Protected Area. *African Zoology,* **41:**275-289.

Rangel, M. O. and Erzini, K. (2007). An assessment of catches and harvest of recreational shore angling in the north of Portugal. *Fisheries Management and Ecology,* **14:**343-352.

Robson, D. and Jones, C. M. (1989). The theoretical basis of an access site angler survey design. *Biometrics,* **45:**83-98.

Roth, E., Toivonen, A. L., Navrud, S., Bengtsson, B., Gudbergsson, G., Tuunainen, P., Appelblad, H. and Weissglas, G. (2001). Methodological, conceptual and sampling practices in surveying recreational fisheries in the Nordic countries - experiences of a valuation survey. *Fisheries Management and Ecology,* **8:**355-367.

Steinback, S. and Gentner, B. (2004). The economic importance of marine angler expenditures in the United States, Professional paper. NOAA, National Marine Fisheries Service.

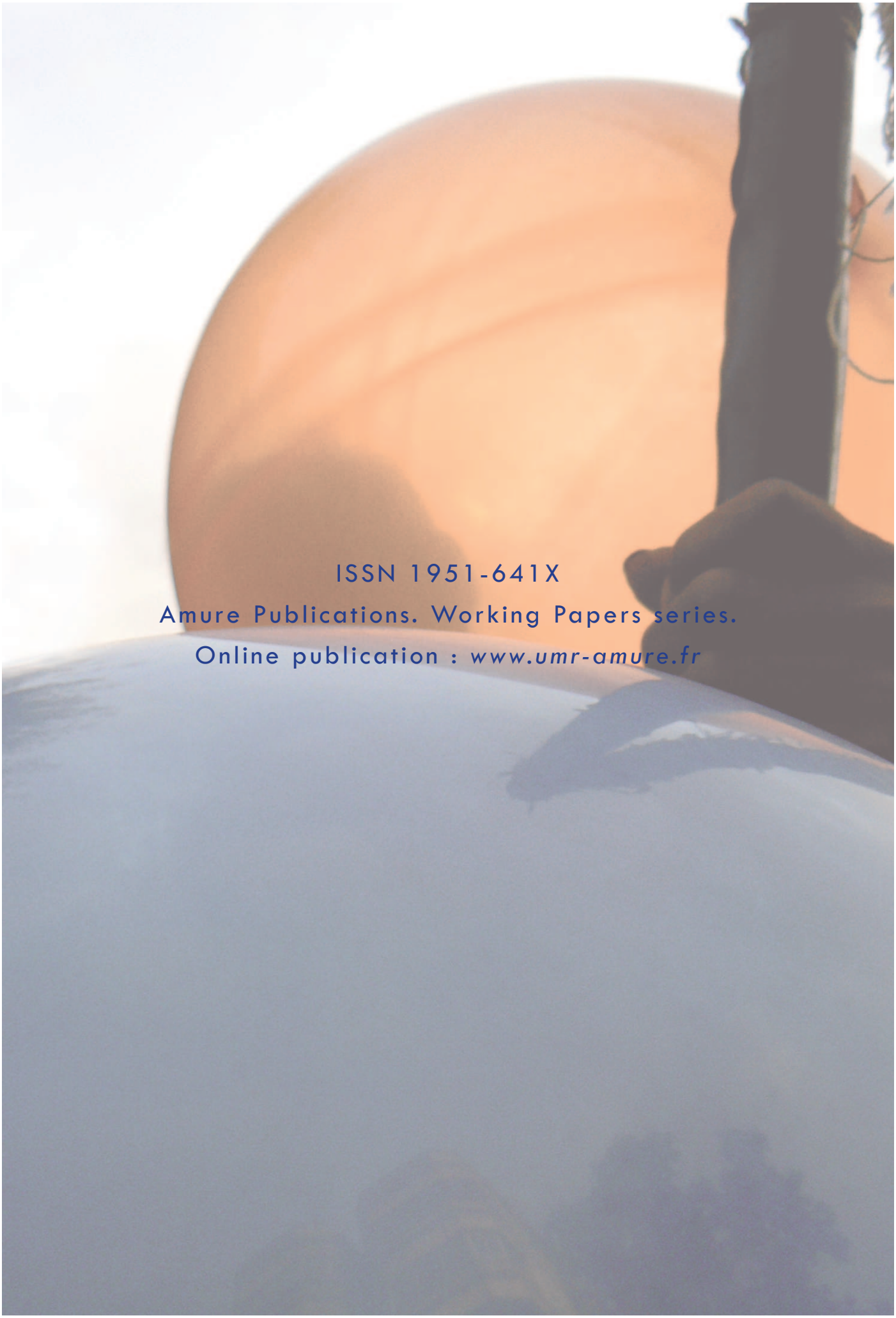
Tarrant, M. A., Manfredo, M. J., Bayley, P. B. and Hess, R. (1993). Effects of Recall Bias and Nonresponse Bias on Self-Report Estimates of Angling Participation. *North American Journal of Fisheries Management,* **13:**217-222.

Toivonen, A. L., Roth, E., Navrud, S., Gudbergsson, G., Appelblad, H., Bengtsson, B. and Tuunainen, P. (2004). The economic value of recreational fisheries in Nordic countries. *Fisheries Management and Ecology,* **11:**1-14.

Véron, G. and Appéré, G. (2004). Pêche récréative en Iroise, in J.Boncoeur. *Activités halieutiques et activités récréatives dans le cadre d'un espace protégé : le cas du Parc Marin de la Mer d'Iroise.* Université de Bretagne Occidentale,153-174.

Weithman, S. A. and Haverland, P. (1991). Comparability of data collected by telephone and roving creel surveys. *American Fisheries Society Symposium,* **12:**67-73.

Wheeler, S. and Damania, R. (2001). Valuing New Zealand recreational fishing and an assessment of the validity of the contingent valuation estimates. *Australian Journal of Agricultural and Resource Economics,* **45:**599-621.



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