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## **Integrating Cultural Ecosystem Services in an Ecosystem Satellite Account: A Case Study in the Gulf of Saint-Malo (France)**

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### **Abstract :**

This paper develops an accounting approach for estimating cultural ecosystem services. Ecosystem satellite accounts should be able to include cultural ecosystem services, which raise numerous assessment difficulties. A new assessment method is proposed, which uses the production for own use of households who carry out recreational activities depending on cultural ecosystem services. An application is carried out in the Gulf of Saint-Malo (France). A survey was implemented in order to collect the accounting data. Six recreational activities mixing the consumption of pure leisure (mainly sport) and marine cultural ecosystem services (mainly fishing and seascape watching) were considered: onshore fishing and shellfish gathering; hiking; recreational boating and offshore fishing; canoeing and kayaking; light sailing; scuba-diving and underwater fishing.

The results show that the household production value for these six marine and coastal recreational activities in the Gulf of Saint-Malo ranges between 210 M€ and 276 M€, contributing to 97% of the output of recreational services for these activities. It means that the current national accounting system captures only 3% of the output of marine recreational activities. About 82% of production means are devoted to the consumption cultural ecosystem services, while the remaining part of the production value is assigned to the consumption of sportive services. Hence, the production value associated to the main uses of marine cultural ecosystem services can be estimated at between 172 and 226 M€, with respective value-added of 110 M€ and 154 M€. These results definitively point out the necessity of distinguishing recreational services which depend only on human activities from cultural ecosystem services which depend on outputs from ecosystem processes, in order to avoid over-estimating or confusing estimates of marine cultural ecosystem services.

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## Highlights

► Households consume cultural ecosystem services thanks to human activities. ► The inputs required for the production of recreational services are estimated. ► The different products of recreational activities are identified and separated. ► We calculate the contribution of cultural ecosystem services to recreational activities consumption.

**Keywords** : Ecosystem satellite account, Household production function, Cultural ecosystem services, Recreational activities

## 1. Introduction

Since the Millennium Assessment (MA) in 2003, there has been a growing interest in literature related to the issue of ecosystem services valuation (Fisher et al., 2009; Laurans et al. 2013). “The Economics of Ecosystem and Biodiversity” (TEEB) initiative defines ecosystem services as the “direct and indirect contributions of ecosystems to human well-being” and has adopted a general framework linking ecosystems with economics based on the famous figure denoting the “cascade” pathway from ecosystem structure and processes to human well-being (de Groot et al., 2010, after Haines-Young & Potschin, 2013 and Maltby, 2009). An ecosystem service is considered to be the result of ecological processes, providing well-being to people thanks to the different benefits generated from these ecosystem services. Under certain assumptions, these benefits can be valued in monetary units. Although they only partially capture the importance of ecosystem services, monetary assessments are considered necessary for internalizing externalities in economic accounting procedures and in policies that affect ecosystems, thereby influencing decision-making at all levels (de Groot et al., 2010; Braat & de Groot, 2012). For the valuation of ecosystem services, welfare economics valuation methods are considered to be the most coherent with standard economic theory (Mäler et al., 2008). However, their implementation poses some serious problems, due in particular to the high level of uncertainty regarding the values of support services and cultural services (Ludwig, 2000; Toman, 1998), and the controversies around the stated preferences analysis for capturing indirect use, non-use, and non-market use values in general (Kahneman et al., 1990; Kahneman and Ritov, 1994; Horowitz and McConnell, 2002).

An alternative approach, the accounting approach, allows the limits specific to welfare economics methods for the valuation of many ecosystem services to be overcome. Following recommendations by Agenda 21, adopted during the Rio Earth Summit in 1992, the statistical division of the United Nations attempted to construct an international accounting framework for the environment: the System of Environmental-Economic Accounting (SEEA), whose first version was published in 1993. Using concepts identical to those of the system of national accounts (SNA) (European Commission et al., 2009), the SEEA seeks to build a coherent assessment framework based on observed transactions (Bos, 1997). After several improvements, the SEEA Central-Framework now provides the inclusion of four kinds of accounts: physical stock and flow accounts, physical accounts (e.g.: physical input-output table), functional accounts (e.g.: environmental protection expenditure account), and asset accounts (United Nations et al., 2014b). In 2012, an experiment was carried out to include ecosystems in the list of natural assets: the SEEA Experimental Ecosystem Accounting (SEEA-EEA). The SEEA-EEA is developing an integrated accounting structure of ecosystem services and ecosystem conditions in both physical and monetary terms (United Nations et al., 2014a). In addition, it is recognized that spatial areas must form the basic focus for ecosystem measurement. Thus, the interest of this approach is its potential ability to explicitly address the interactions between ecosystems and human activities (Edens and Hein, 2013), which can be depicted and assessed at the scale of spatial units corresponding to well-identified terrestrial or marine ecosystems. This approach could serve as the basis for building ecosystem satellite accounts, especially for marine areas of high ecological importance, which would necessitate stronger management institutions.

One specific challenge in building an ecosystem satellite account remains the assessment of cultural ecosystem services. Indeed, the value of cultural ecosystem services cannot easily be captured by observed transactions. In addition, they include a wide range of services, some of them are social

constructs showing little dependence on the state of the ecosystems (Daniel et al., 2012). According to the MA (2003), cultural services are the “nonmaterial benefits people obtain from ecosystems,” and include “cultural diversity, spiritual and religious values, knowledge systems, educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values, and recreation and ecotourism”. From an ecosystem services accounting perspective, only recreational activities could reasonably expect to be included within a quantitative assessment. In an attempt to provide a more comprehensive and rigorous definition of cultural ecosystem services, the Common International Classification of Ecosystem Services, developed by the European Environment Agency, distinguishes four types of cultural ecosystem services: physical and experiential interactions, intellectual and representative interactions, spiritual and/or emblematic values, and other cultural outputs (CICES 2013). It is notable that this classification, which has been elaborated for accounting purposes as it is a contribution of the EEA to the revision of the SEEA, unfortunately avoids the use of the terms “recreation” or “recreational activities”.

The ongoing debate regarding the scope and definition of cultural ecosystem services demonstrates the need to clearly define the status of outdoor recreational activities when building an ecosystem service accounting framework. Boyd and Banhzaf (2007) point out that recreation should more appropriately be considered a benefit produced using both ecological services and conventional goods and services. In this paper, we adopt the proposal by Edens and Hein (2013) who define, for the purpose of ecosystem accounting, ecosystem services “as the contributions of ecosystems to productive activities or to consumptive activities” (p. 44). This definition is particularly well suited for the building of supply and use ecosystem satellite accounts, which would incorporate all human activities using ecosystem inputs (for productive activities) or services (for consumption activities). This paper aims at demonstrating that such a satellite ecosystem account based on supply and use tables could provide an accurate assessment of cultural ecosystem services, providing that relevant conventions are adopted for the inclusion of recreational activities.

Recreational services are mostly produced by households themselves for their own use. Up to now, the household production for services for own use is outside the scope of the SNA and thus excluded from the national economic tables. Since 1980s, there have been attempts to value non-market household production for services for own use from an accounting perspective, by developing a household satellite account (Eurostat, 2003). However, housework production is included in, but not the production of, outdoor activities, such as recreational activities. This paper proposes a methodology for including in an ecosystem satellite account focused on the marine cultural ecosystem services, the production for own use of recreational activities by households. Recreational services generate a mix of benefits, some of which are not directly connected to ecosystems. In order to focus on services which depend on physical or experiential interactions with ecosystems (according to the CICES definition of cultural ecosystem services, CICES 2013), this paper proposes a consumption time criterion in order to disentangle cultural ecosystem services from other benefits of outdoor activities, in particular pure leisure activities like sport. At last, the methodology is tested empirically on a marine ecosystem located in northwestern France, the Gulf of Saint-Malo. A supply and use table for the consumption of cultural ecosystem services is estimated for six recreational activities.

The article is structured as follows. The first section presents the accounting concepts and principles used to construct the ecosystem satellite account devoted to the recreational activities that enable

households to consume cultural ecosystem services. The second section describes the implementation of the satellite ecosystem account for household marine recreational activities for own use carried out in the Gulf of Saint-Malo. The third section describes the main results. The conclusion addresses the strengths and limits of this approach which aims at providing a monetary assessment of household recreational activities consuming cultural ecosystem services.

## **2. Estimating Household Production for Own Use in the Case of Recreational Activities Using Cultural Ecosystem Services**

### *2.1. Accounting Concepts for Defining Household Recreational Activities*

This section defines the conventions and concepts mobilized in this paper to value household production for their own use in the context to the construction of an ecosystem satellite account. Two fundamental concepts must be mobilized in order to define recreational activities from an accounting perspective: the difference between an economic activity and a product, and the distinction between productive activities and consumptive activities.

Products are defined in the national accounts as the goods and services produced within an economy to be consumed by institutional units. They are the output of economic activities. On the other hand, economic activities are related to the production process, namely the combination of inputs (labour, capital, ecological inputs, and goods and services) implemented by institutional units in order to produce the products. For example, the number of fish landed is the product of the fishing activity, whereas the fishing activity is a combination of inputs (labour like the fishermen workforce, capital such as boats, provisioning ecosystem services corresponding to the delivery of consumable fishes by the sea, and goods and services like petrol and insurance). It is important to note that an economic activity can produce multiple products and a product can also be produced by multiple economic activities. Productive activities are related to the production process, whereas consumption activities are related to the consumption process of products (goods or services).

In relation to the issue of household activities, Eurostat (2003) defines household production as the combination of unpaid labour, capital, and intermediate goods and services used to produce goods and services. In the household satellite account, the time is the reference unit used to physically estimate the unpaid labour. This time is called the 'production time'. The other components are quantified with monetary units. In order to have a homogeneous measure of household production the production time is translated into monetary units. Eurostat's definition is consistent with the general definition of activities, since it considers that households are able to mobilize inputs in order to produce goods and services. According to this definition, household recreational production is the combination of inputs - unpaid labour, capital, ecological inputs, and goods and services - required to produce recreational services. For example, to carry out recreational fishing, households should mobilize unpaid labour (e.g. time for preparation and travel), capital through the purchase of large equipment (e.g. boat), ecological inputs corresponding to the presence of fishes for recreational activities, and the purchase of goods and services (e.g. petrol, insurance, location).

An issue can be raised about the use of the terminology 'production time' (preparation and trip time) in the specific case of recreational activities. Indeed, households carry out recreational activities to

enjoy themselves. During the preparation and trip time, households are for the most time engaged in their recreational activities. This production time can thus contribute to the pleasure provided by recreational activities. However, it is important to mention that, according to national accounts conventions, the pleasure notion cannot be used to distinguish between paid or unpaid work. These two notions, pleasure and work, can be in fact compatible. For instance, some people enjoy their job time. This is largely the case for employees working in professional recreational activities. Yet these activities are recorded in the national accounts. This is also the case for time devoted to housework. Some individuals enjoy their unpaid household work (e.g. preparation of meals, ironing). Never the less, a satellite household accounting framework was constructed to value homework production carried out by households (Landefeld and McCullan, 2000). In our accounting approach, the preparation and trip time is considered as production time (unpaid work), since this time is required to create recreational services. The different members of a household cannot benefit from services provided by recreational activities if the preparation and trip time was not implemented by this household.

As for economic activities, recreational activities produce outputs, some of which correspond to cultural services. They can be quantified physically as the time devoted to the consumption of cultural services. This time is called the 'consumptive time'. The genuine benefit to individuals provided by recreational services arises during the consumptive time. As for other commodities produced by economic activities, households increase their satisfaction when they consume these commodities. For recreational fishing, the time spent on a fishing site corresponds to the consumption time of cultural ecosystem services, which could encompass recreational fishing and seascape watching.

## *2.2. Linking Cultural Ecosystem Services and Household Recreational Activities Within an Ecosystem Satellite Account*

According to an ecosystem satellite account approach, household activities are the economic processes through which people gain access to the consumption of cultural ecosystem services. Indeed, people have to implement different inputs or means -both material and human means- in order to benefit from cultural ecosystem services. People would not be able to consume cultural ecosystem services if these different means were not mobilized. Of course, a part of these recreational activities is recorded in the national accounts: these are mainly the activities carried out through professional bodies like sportive associations or nautical centres. However, another part of recreational activities is outside the national accounts: this concerns the household production for own use. As the first objective of this paper is to contribute to the improvement of the assessment of cultural services in satellite ecosystem accounts, we must develop accounting conventions in order to value household recreational activities. Excluding the later activities in an ecosystem satellite account would imply underestimating the production value of recreational activity motivated by the consumption of cultural ecosystem services.

It is thus important to scrutinise human activities in order to improve our understanding of the process of the consumption of cultural ecosystem services. Up until now, no study has precisely examined the link between human activities and ecological inputs for cultural ecosystem services, in line with the most recent definition adopted by the CICES (2013). When considering recreational

activities as a means to estimate the benefits people obtain from cultural ecosystem services, it is fundamental to consider only those benefits that depend on ecosystems. As the second objective of this paper is to focus on services that depend on physical or experiential interactions with ecosystems, according to the CICES definition of cultural ecosystem services, our accounting methodology uses the consumption time criterion in order to disentangle cultural ecosystem services from other benefits of outdoor activities, in particular pure leisure activities like sport.

These different services are identified by studying what the households do during their consumption time. Two types of services produced by recreational activities are distinguished. Households generally use consumption time to enjoy cultural ecosystem services, like seascape viewing or recreational fishing, and/or doing sports. These services are in fact joint products of recreational activities in the sense that they can be an output of the same production process. So, households benefit from cultural ecosystem services by consuming products supplied by the recreational activities, but the link between recreational activities and cultural ecosystem services is not bijective, since households can make recreational activities to benefit from sport services. It is thus important to discriminate within the consumption time, the time devoted to the consumption of cultural ecosystem services and also to estimate the inputs mobilized by households to consume these services. Generally, households can evaluate by themselves the part of the consumption time devoted to the different services (i.e., to do pure sport activities and to enjoy cultural services) provided by the recreational activities. An important issue is then to define a method for assessing the part of the production value necessary for the consumption of cultural ecosystem services to occur.

Fig. 1 summarizes the theoretical accounting framework for the valuation of recreational activities consuming cultural ecosystem services.

< Insert Fig. 1 >

### *2.3. Accounting Concepts for Valuing Household Production and Consumption of Cultural Ecosystem Services obtained from Recreational Activities*

According to Eurostat (2003), there are two approaches for valuing production: the input approach, in which the production is valued at cost, and the output approach, in which it is valued at observed market transactions. The output approach aims at estimating the value of production by multiplying the quantity of output by a market price. In the case of recreational activities, the output quantity represents the consumption time (in hours) and the price would be the average market price for 1 h of consumption. However, the services provided by household production are not exchanged on a market. So there are no prices for the services produced by a household for own use. An alternative is to use the prices of equivalent market services. This approach is the best option for the SNA, since it integrates a surplus in production. However, it is based on strong assumptions: that households have the same production process as companies and that the services provided by households and companies have the same characteristics. These assumptions are too unrealistic to be applied (Eurostat, 2003).

The second-best solution proposed by the SNA is to value the production based on its production cost. The advantage of this valuation approach is that it better incorporates the specific production processes. It could also be interpreted as the minimum value of production, since the surplus is not incorporated. This method is used in the SNA for public non-market production like public education and health. It is also the most chosen method for household satellite production accounts (Eurostat, 2003).

The production value of recreational activities is usually made up of three components according to the system of national accounts (European Commission et al., 2009): purchase of intermediate products (non-durable products), payments for unpaid labour, and consumption of fixed capital (depreciation of fixed assets).

Concerning the first component, the purchase of final products for the purpose of the production of recreational activities must be extracted from the household final consumption. These products, considered as final products in the SNA, become intermediate products in the household satellite account (Landefeld and McCulla, 2000). However, some of these intermediate goods and services, although consumed during recreational activities, are not integrated in the household satellite account: this is the case for accommodations and catering services. For accommodation services, it is quite impossible to know for which main purpose the household has paid for a room. Regarding catering services, households should pay for their food no matter what activities they are doing.

The second component concerns the payments for unpaid labour and requires further discussion. Unpaid labour is expressed in production time. It corresponds to the quantity of time (expressed in number of hours) needed in order for recreational activities to be produced. Two types of time should be distinguished: i) the preparation time, corresponding to the amount of time devoted to search information and to purchase products, and ii) the travel time, corresponding to the amount of time needed for travel from the place of domicile to the place where the recreational activity is carried out. After determining the production time, a crucial issue is knowing which wage-based methods to use in order to impute a monetary value to the production time corresponding to the payment of unpaid labour. Two methods are explored to estimate the wage rate: the replacement wage and the opportunity cost (Eurostat, 2003). Concerning the opportunity cost, the remuneration of unpaid work is equal to the wage forgone by households, which is the wage households would have received had they spent this time to work instead of producing non-market services. On the other hand, the replacement wage corresponds to the wage of jobs requiring similar tasks and abilities that the households would need to produce non-market services. The opportunity cost was abandoned because it is based on welfare concepts that are not consistent with accounting concepts (Goldschmidt-Clermont and Pagnossin-Aligisakis, 1999; Blades, 1997; Chadeau, 1992; Eurostat, 2003; Levrel et al., 2010). The replacement costs are more consistent with accounting principles. However, for a similar job, different salary levels could be applied: the salary of the least qualified and a reference salary. This difference is explained by the change in productivity depending on the experience and the skills of the workers. There is a debate around choosing which salary should be retained (Level et al., 2010). According to Poissonnier and Roy (2013), the wage of the least qualified should be applied. The productivity of workers is assumed to be greater than households, since the companies and associations have an important capital stock with mass production leading to an increasing return to scale and therefore better productivity. However, as indicated by Levrel et al. (2010), it is also possible to find arguments saying that households are as productive as workers. For



instance, households could have significant experience producing non-market services with excellent skills. Moreover, households could also have a strong time constraint. In fact, it is impossible to decide upon the best replacement wage. This is why we have made two valuation scenarios in this article. Another important discussion concerns whether it is the gross or the net wage that should be retained. The gross wage is used, since it is the most coherent with the national accounts' concepts of compensation of employees (Landefeld et al., 2009).

The third component, the consumption of fixed assets, corresponds to the depreciation of fixed capital. This component indicates the household budget devoted to the replacement of obsolete capital. However, according to the SNA conventions, the net return to capital should not be included when own-account production is undertaken by non-market producers. The widespread international method used to estimate the consumption of capital formation is the "perpetual inventory method" or PIM. It is also the recommended method for household production (Schäfer and Schwarz, 1994; Blades, 1997; Eurostat, 2003). The following information is needed to estimate the consumption of fixed capital: the value of capital formation each year and the length of service life. It is thus important to spot the main assets used by households to produce recreational services.

#### *2.4. Valuing Household Production and Consumption of Cultural Ecosystem Services in the Presence of Joint Products*

Once the household production for recreational activities has been estimated using standard accounting techniques, the proper assessment of cultural ecosystem services necessitates breaking down this production value into the consumption of the different services consumed during the activity.

As for the production processes in firms, households can produce different products, a main product and secondary products. For instance, recreational activities can produce a main product like "extraction of halieutic resources" and also secondary products, such as "seascape observation" or "sport." In the national accounts, the difference in these products coming from an industry is indicated in the supply table. As for the national accounts, an ecosystem satellite account should differentiate the main product from the secondary products coming from household production. In the SNA, the breakdown factor generally used in the production of different products coming from the same activity is the sales revenue. For instance, the total sales revenue of industry A is given as 70% from the sale of product X and 30% from the sale of product Y. The production of products X and Y is assumed to contribute to 70% and 30%, respectively, of the total production value of industry A.

In the specific case of recreational activities, the breakdown factor cannot be the sales revenue, since the products are not sold on a market. Thus, the situation is the following: on one hand, the production value of recreational activities can be estimated using standard accounting techniques but cannot be broken down into different production processes or services. On the other hand, individuals are able to estimate the share of each product or service in the benefits they obtain from a recreational activity: this could allow them to declare how much of the consumption time is dedicated to each of these different benefits. Therefore, a possible solution is to use the time that

the households spend consuming the different products coming from the recreational activities as the factor for breaking down the production value into the different products or services. Then, the share of each of the services in the total production value is simply assumed to be equal to its share of the consumption time. For instance, the household production of hiking activity in a given area is equal to €20,000. Households declare that during hiking they devote 70% of their time to enjoying the landscape and the other 30% of their time to doing sports. Thus, the production needed for landscape watching is assumed to be equal to  $€20,000 \times 0.7 = €14,000$ . The consumption time is the key factor used to break down household production value into the different products obtained from an activity. Fig. 2 summarizes the breakdown of recreational activity production value according to the consumption time of recreational services.

< Insert fig. 2 >

This section presented the different accounting concepts used to calculate the household production of recreational services. The next section provides an application for the assessment of recreational activities using marine cultural ecosystem services in the Gulf of Saint-Malo.

### **3. Building a Satellite Ecosystem Account for Household Recreational Activities Using Marine Cultural Ecosystem Services**

In order to demonstrate the feasibility of an ecosystem satellite account including recreational activities that rely on marine cultural ecosystem services, we applied the valuation methods described in the previous section to the recreational activities carried out by households in the Gulf of Saint-Malo. Building such a satellite account requires delimiting its scope by defining the geographical area it will cover, the recreational activities it will encompass, and the households whose production of recreational services for own use that must be included. The accounting data will then be gathered through a survey<sup>1</sup>.

The Gulf of Saint-Malo is located in the western part of the English Channel and in the northwest of France with a marine surface area of 11,000 km<sup>2</sup>. Fig. 3 shows a map the Gulf of Saint-Malo. Three French departments have coastlines within the gulf of Saint-Malo: two departments in the Brittany region (Côtes d'Armor and Ille-et-Vilaine) and one department in the Normandy region (Manche). The satellite account will consider the recreational activities that take place on the coastal zone or at sea between Bréhat island and Cap de la Hague, which form the functional boundaries of the Gulf of Saint-Malo marine ecosystem according to the local marine environment managers<sup>2</sup>.

< Insert Fig. 3 >

Different recreational activities take place in this geographical area. The second step of the satellite account elaboration is to identify which of these different recreational activities depend on cultural

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<sup>1</sup> It is important to mention that the regional accounts at this geographical area are not very developed in France. Thus, economic accounting indicators like production value, added value are not published at the level of the Gulf of Saint-Malo. Besides, the number of employments indicated in the population census is too aggregated in order to measure the contribution of recreational activities.

<sup>2</sup> This satellite account of recreational activities was developed in support of the work carried out by the French Marine Protected Area Agency to prefigure the creation of a future MPA in the Normand-Breton Gulf.

ecosystem services. Six recreational activities related to cultural ecosystem services were found: i) onshore fishing and shellfish gathering, ii) hiking, iii) recreational boating and offshore fishing, iv) canoeing and kayaking, v) light sailing, and vi) scuba-diving and underwater fishing. The recreational fishing activity is considered here as a cultural ecosystem service, as mentioned in the Common International Classification of Ecosystem Services (CICES). Of course, it could also be considered as a provisioning ecosystem service if the primary motivation for fishing was to supply food. However this would imply that the benefits generated by this practice would be higher than the costs supported by the recreational fishers. This is clearly not the case today in France (Herfaut et al., 2013). Indeed, in France, like in most developed countries, subsistence fishing is relatively marginal (Pawson et al., 2008). The different services provided by these activities can be identified by studying what the households do during their consumption time. Four services are distinguished coming from these recreational activities: i) enjoying the seascape, ii) enjoying the underwater seascape, iii) extracting halieutic resources, and iv) doing sport.

Third, the satellite account should incorporate all households doing recreational activities in the Gulf of Saint-Malo. However, the larger the survey area, the greater the cost of the survey. It is important to find the optimal study area that respects the budget constraint while still including a good representation of households' practices. Unfortunately there is no information available which indicates the place of residence of these households. We assume that the three departments (Côtes d'Armor, Ille-et-Vilaine, and Manche) where the Gulf of Saint-Malo is located will provide a correct estimation considering these two constraints. Indeed, households living in these three departments have less than 3 h round-trip by car between their place of residence and the coast. Besides, households living outside of the three departments do not have any incentive to do their recreational activities specifically in the Gulf of Saint-Malo, since they are far from the area and can find a suitable location closer to their place of residence. In addition, we assume that tourists prefer to do recreational activities with the aid of associations or companies, since they do not generally have the required abilities and equipment to do these activities by themselves. The three departments have 2,157,232 inhabitants and 920,620 households. These three departments include some large cities such as Rennes (208,033 residents), Saint-Brieuc (46,173 residents), Saint-Malo (45,201 residents), and Cherbourg (37,754 residents).

The statistical unit considered in the survey is the household. The survey's questionnaire is composed of three parts. The first part is related to the consumption process of the six recreational activities. The respondent was asked to estimate for each individual of the household the frequency and average duration of the six recreational activities over the last year (2013). This information made it possible to estimate the consumption for individuals and for households. Then, households were invited to declare the portion of the consumption time devoted to the consumption of the different recreational services, namely i) enjoying the seascape, ii) enjoying the underwater seascape, iii) extracting halieutic resources, and iv) doing sport. The second part of the survey is related to the production process. Households were asked to estimate the quantity of inputs they mobilized in order to carry out the recreational activities, namely the purchase amount of non-durable goods and services (intermediate products) and the time devoted to preparation and travel. Concerning the durable goods (investment goods), the year, the age, and the purchase amount of these goods were also asked. The main different expenditure items for these six recreational activities were pre-identified thanks to the sport federations. The survey determined whether the household carried out these recreational activities for personal use only or with the support of associations or companies.

This helped us to assess the part of the recreational activities produced by households for their own use relative to associations and companies. The third part of the survey provides the main characteristics of the households for the need of statistical extrapolation: age of household head, household size, and socio-professional category.

The survey was implemented by the polling institute BVA through phone interviews. There were 1,503 households interviewed, corresponding to 0.16% of the population. The method used by the BVA is the stratified sampling by adopting the quotas on the household structure per department. The sample was then adjusted in order to match the same structure found in the population. Table 1 compares the sample structure with population structure.

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## **4. Results**

### *4.1. Direct Information Coming from the Survey*

#### *Penetration rate*

One of the first results derived from the survey is the estimate of the penetration rate for the six recreational activities. Table 2 presents the penetration rates and the number of households and individuals (including children) benefiting from recreational services produced by themselves.

< Insert table 2 >

Table 2 shows that one out of four individuals and more than one out of four households located in the three departments carried out at least one of the six recreational activities in the Gulf of Saint-Malo. Onshore fishing and hiking are the two main recreational activities practised, with a penetration rate higher than 10%. On the other hand, light sailing, scuba-diving, and kayaking are the recreational activities the least practised with a penetration rate not exceeding 4%.

One important result of this survey is that it shows in what context the households carry out their recreational activities (personal context or associations and companies). When households do their recreational activities using associations and companies they delegate a part of the means to produce recreational services to third parties. Table 3 indicates in which context the households carried out the recreational activities.

< Insert table 3 >

One interesting result is that recreational activities are carried out largely outside of associations and companies. For the six recreational activities, more than 70% of households carry out these activities in a personal context. This result demonstrates that the recreational industry indicated in the SNA does not reflect the output of recreational activities, and it highlights the benefit of constructing a household account in a satellite ecosystem accounting for marine recreational activities.

### *Consumption time*

Data from the survey allows us to easily calculate the average consumption time for each recreational activity. This information indicates the time spent by households to consume each kind of recreational service provided by the recreational activities. The results are shown in Table 4.

< Insert table 4 >

The household yearly average consumption time for each recreational activity is divided into three factors: i) the frequency (the number of times that individuals practise recreational activities), ii) the duration (how much time the individuals spend on the site when they practise recreational activities), and iii) the average number of individuals practising these activities in a household. The recreational activities having the greatest consumption time are hiking (100h48' per household practising the activity) and light sailing (95h50'). For these two activities, this result is explained by the frequency rather than the duration, and the number of individuals practising these activities. The recreational activities having the lowest consumption time are onshore fishing and scuba-diving. This is explained mainly by the frequency and the duration, and also by the number of individuals per household practising scuba-diving.

It is possible to precisely estimate the part of consumption time devoted to each recreational service for all recreational activities. The benefits of cultural ecosystem services arise during their consumption. This information is given in Table 5.

< Insert table 5 >

For onshore fishing and recreational boating, over half of the consumption time is for extracting halieutic resources (57% for onshore fishing and 52% for recreational boating). The remaining consumption time is devoted to enjoying the seascape (41% for both onshore fishing and recreational boating). For hiking and kayaking, over half of the consumption time is spent enjoying the seascape (66% for hiking and 57% for kayaking), while the remaining consumption time is generally used to practise the sport (36% for kayaking and 34% for hiking). It is important to note that the role of sportive services in recreational services for hiking and kayaking is quite significant. For scuba-diving, almost half of the consumption time is devoted to enjoying the underwater seascape, while 26% is used to extract halieutic resources. Sportive services represent 20% of the consumption time. It is interesting to note that scuba-diving is the recreational activity having the greatest diversity in the consumption time. For light sailing, over half of the consumption time (58%) is devoted to sportive services, while the remaining time is spent enjoying the seascape.

The results of Table 5 are used to break down production into the different recreational services for each recreational activity.

### *Production time*

The results of the survey also indicate the production time divided between preparation time and travel time. Information from the production time is shown on Table 6.

< Insert table 6 >.

Recreational boating and offshore fishing are the activities where the production time is the greatest (40h30' per year and per household), whereas onshore fishing and shellfish gathering are the activities where the production time is the lowest (16h12' per year and per household). The change in production time between the different activities is mainly explained by preparation time rather than travel time.

### *Synthesis*

The Fig. 4 summarizes the average production time with consumption time for each recreational activity.

< Insert Fig. 4 >

The scuba-diving activity has the lowest consumption/production ratio: 1 h of consumption in the scuba-diving requires 45 min of production. This is explained by a relatively low consumption time (because it is a strenuous physical activity, which necessitates also many also security precautions) and also by a quite relatively high production time (explained mainly by the travel time). On the contrary, light sailing is the activity having the highest consumption/production: 1 h of consumption in the light sailing requires only less than 16 min of production time. This is in fact explained by a high consumption time rather than a low production time, the latter is in fact relatively close to the average production time of other recreational activities.

### *4.2. Accounting Values*

Production value is composed of three components: the purchase value of intermediate products (intermediate consumption), the remuneration of unpaid work, and the consumption of fixed capital. The sum of the last two components corresponds to the value-added. The purchase value of intermediate products was easily estimated thanks to survey data indicating the purchase value for each item bought. For the remuneration of unpaid work, as indicated in 1.3., two types of wages can be applied: the wage of the least qualified and the reference wage. Sport instructor is the most similar job equating to household unpaid work producing recreational services. The gross wage of the least qualified sport instructor is a minimum hourly wage equal to 9.43€ (scenario A), whereas the reference gross hourly wage for this job is 15.74€ (scenario B). We impute this value to the production time, calculated as the average production time per households (indicated in the Table 6) with the number of households carried out each of recreational activities (indicated in the Table 2). Data from production time also enables us to estimate the physical value of labour input expressed in full time equivalent (FTE) jobs, since one FTE job is equal to 1,519 h. The consumption of fixed capital is calculated by using the perpetual inventory method as indicated in the first section.

Tables 7 and 8 show supply/use accounting tables for the different recreational activities for scenarios A and B, respectively. The production value is an indication of the different means implemented by households in the three French departments in order to produce recreational services linked with cultural ecosystem services.

< Insert tables 7 and 8 >

The use table indicates the value of different (economic) inputs mobilized by households to produce marine recreational activities. The production value is the sum of these different input values. The household production value for these marine recreational activities ranges between 210 M€ and 276 M€ for 2013 according to scenarios A and B, with value-added rates equal to 58% and 68%, respectively. The achievement of all of these activities necessitated an equivalent labour input of 6,867 FTE. By comparison with the value-added rate of the recreational industry, which is equal to 54%, scenario A is closer to the ratio indicated by national accounting. Recreational boating and offshore fishing are the activities where production is the greatest (78 M€ and 94 M€ for scenarios A and B, respectively), whereas scuba-diving and underwater fishing are the activities where production is the lowest (7 M€ and 16 M€ for scenarios A and B, respectively).

It is important to note that the production value of recreational activities included in the System of National Accounts is estimated in the Gulf of Saint-Malo at 6 M€. It represents, in fact, less than 3% of the real value of recreational activities. Standard national accounting is thus not adequate to value recreational activities depending on cultural ecosystem services. It highly underestimates the recreational activity value. Hence the interest to construct an ecosystem satellite account linking household production of recreational activity for own use and ecosystem services in order to obtain a better value of these recreational activities.

Besides, the estimate of the value of the household production for own use in an ecosystem service accounting framework enables us to assess the economic impacts induced by the presence of cultural ecosystem services. Indeed, households should purchase specific goods and services (recorded as intermediate consumptions and investments) in order to enjoy ecosystem services. Thanks to this information, it is possible to estimate economic impacts for activities included in the national accounts of household recreational activity production. For instance, participating in hiking activities implied the purchase of more than 19 M€ by households (recorded as intermediate consumptions). This value also represents the economic impacts for economic activities (in other words, revenues for economic sectors coming from of these expenditures). The results show that recreational boating and offshore fishing are the household activities having the strongest economic impacts, as they require a high value purchase of goods and services, explained mainly by a significant equipment cost. This information is important for policy markets in order to estimate a better value of economic impacts explained by a good state of ecosystems.

The supply table breaks down the value of household marine recreational activity production according to the services provided by these activities (i.e. products of marine recreational activities). The criterion used to break down the value of household recreational activity production is the consumption time data. The production of activity products indicates the means implemented by households to consume each of the different recreational services. A great part of the means implemented to produce recreational services is for the consumption of ecosystem services (82%). Almost half of the production is devoted to enjoying the seascape and 32% to extracting fishing resources. It is also important to note that the part of the means devoted to consuming sportive services is estimated at 18%.

The supply table is an important table in order to assess the dependence of household recreational activities on cultural ecosystem services. It indicates the part of production explained by the

presence of these ecosystem services. For instance, all household production for onshore fishing is entirely explained by the consumption of cultural ecosystem services. On the contrary, household production for light sailing is relatively lowly dependent on cultural ecosystem services (41% of production value). Households perform this activity for mainly sportive purposes.

## 5. Conclusion

In this study, a method was developed for estimating the means implemented by households in order to benefit from marine cultural ecosystem services. This method is based on accounting principles and consists of estimating the production for own use of households who carry out recreational activities depending on cultural ecosystem services. Using consumption time as a criterion for separating cultural services from other joint products of recreational activities allows us to improve the accuracy of cultural ecosystem service estimates. The method was applied to the Gulf of Saint-Malo for six recreational activities using marine cultural services: onshore fishing and shellfish gathering; hiking; recreational boating and offshore fishing; canoeing and kayaking; light sailing; scuba-diving and underwater fishing.

The results show that the production value of these recreational activities ranges between 210 M€ and 276 M€ for 2013 depending on which replacement wage is used (the least qualified wage and the average wage for a sportive instructor, respectively). This production value is broken down into 89 M€ for intermediate consumption (purchase of intermediate products), 98 M€ - 164 M€ for the remuneration of unpaid work (human means), and 23 M€ for the consumption of fixed capital (depreciation of produced capital). The working time provided by households to carry out these recreational activities is equivalent to 6,867 salaries working full time. Recreational boating and offshore fishing are the activities whose production values are largely explained by the significant amount of material cost (mainly the purchase of intermediate products and the depreciation of produced capital), while scuba-diving and underwater fishing are the activities where the production values are the lowest, explained by the small number of participants. The accounting framework uses a new method based on the consumption time criterion in order to identify the share of recreational services consumption that strictly corresponds to the consumption of cultural ecosystem services, depending on ecosystem status. Thanks to this information, it was possible to estimate the part of production that is necessary for the consumption of cultural ecosystem services. Our case study indicates that about 82% of the production value of marine recreational activities is devoted to the consumption of cultural services, broken down into 46% for enjoying the seascape, 32% for extracting fisheries resources, and 4% for enjoying the underwater seascape. The remaining part of the production value is assigned to the consumption of sportive services.

The results presented in this paper overcome the limits of the system of national accounts for the recreational activity issue. Indeed, national economic accounts undervalue the output of recreational activities, since they do not consider the household production for own use. For instance, without considering household production of services, the production value of recreational activities in the Gulf of Saint-Malo mainly carried out through associations is estimated at 6 M€ with the number of employees equal to 106 FTE, i.e., less than 3% of our estimates of recreational production value. Hence, this demonstrates the importance of extending the national accounts to household production for own use of recreational services. In addition, this methodology offers a solution for



calculating estimates of the link between recreational activities and cultural ecosystem services that appear to be more accurate when compared to the results coming from the current national ecosystem service assessment experiences. For instance, a survey was conducted in 2012 by the Environment Canada Enquiry Centre in order to estimate the number of participants in recreational activities and calculate the expenditures associated. However, this survey only took into account the material means implemented by households to do recreational activities, and did not consider the human means. Moreover, no distinction was made between the sportive services and the cultural ecosystem services consumed through these recreational activities.

In our accounting approach, recreational activities are only dependant on the cultural ecosystem services. We know that recreational activities are in fact not only dependant on these ecosystem services, but also on other indirect ecosystem services like regulation ecosystem services. It is important to note that an ecosystem satellite account should be focused only on the direct ecosystem services used as ecological inputs for human activities.

It is important to emphasize that the different national experiences of valuing cultural ecosystem services are mainly based on welfare economic values (Bateman et al., 2011). The values are estimated by using non-market monetary valuation methods, which are based on some debated assumptions. For instance, ecosystem services are assumed to be substitutable with economic products (Farber et al., 2002). Because of these theoretical limits, the results coming from these valuation methods are rarely valid or reliable (Smith, 1993; Venkatachalam, 2004), which prevents us from comparing or aggregating the estimates of ecosystem services obtained using these valuation methods. On the other hand, the use of such debatable assumptions in the accounting approach is limited because the valuation principles are strictly descriptive, since they are based on current transactions and observed values (Bos, 1997). Thus, the results are more robust with a relatively low cost associated with obtaining these accounting data. In addition, such estimates can support valid comparisons or aggregate with other estimates of the means implemented to benefit from various ecosystem services. However, this approach remains incomplete. A comprehensive accounting framework for marine cultural services should also provide monetary estimates of the means dedicated to the avoidance of ecosystem degradation due to recreational activities and to the maintenance of the ecological outputs which support the consumption of cultural services.

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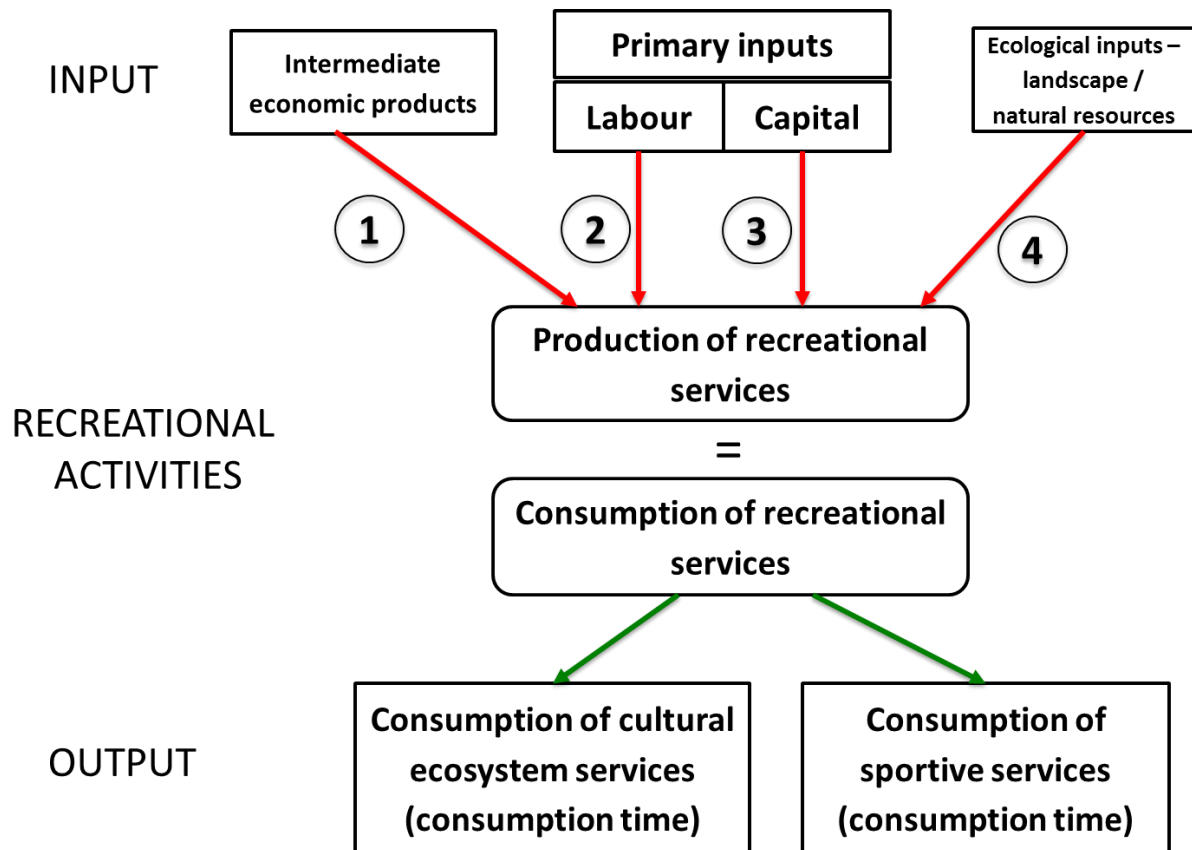
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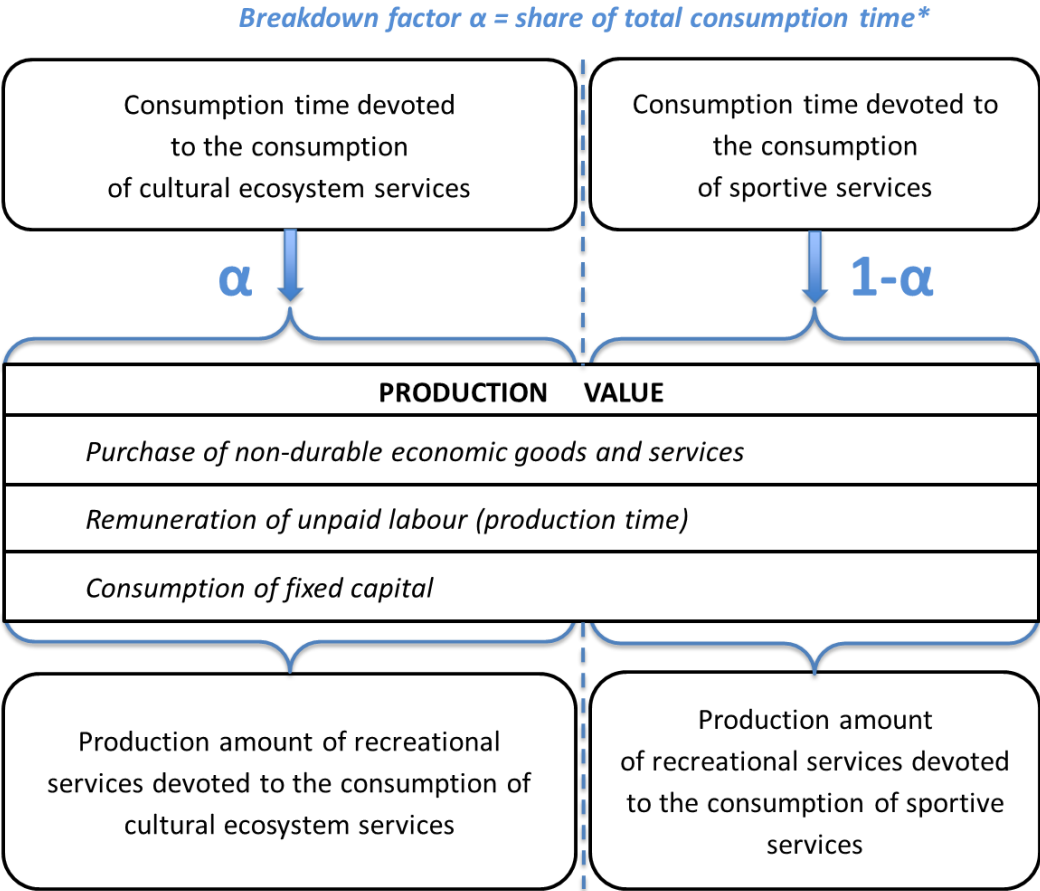
### List of figures

Figure 1: Accounting framework for the valuation of recreational activities consuming cultural ecosystem services



- (1): Purchase of non-durable goods and services (intermediate consumption of households);
- (2): Payments of unpaid labour (value of production time);
- (3): Consumption of fixed capital;
- (4): Free contribution of ecosystems to production of recreation services

Figure 2: Breakdown of recreational activity production values according to the consumption of recreational services

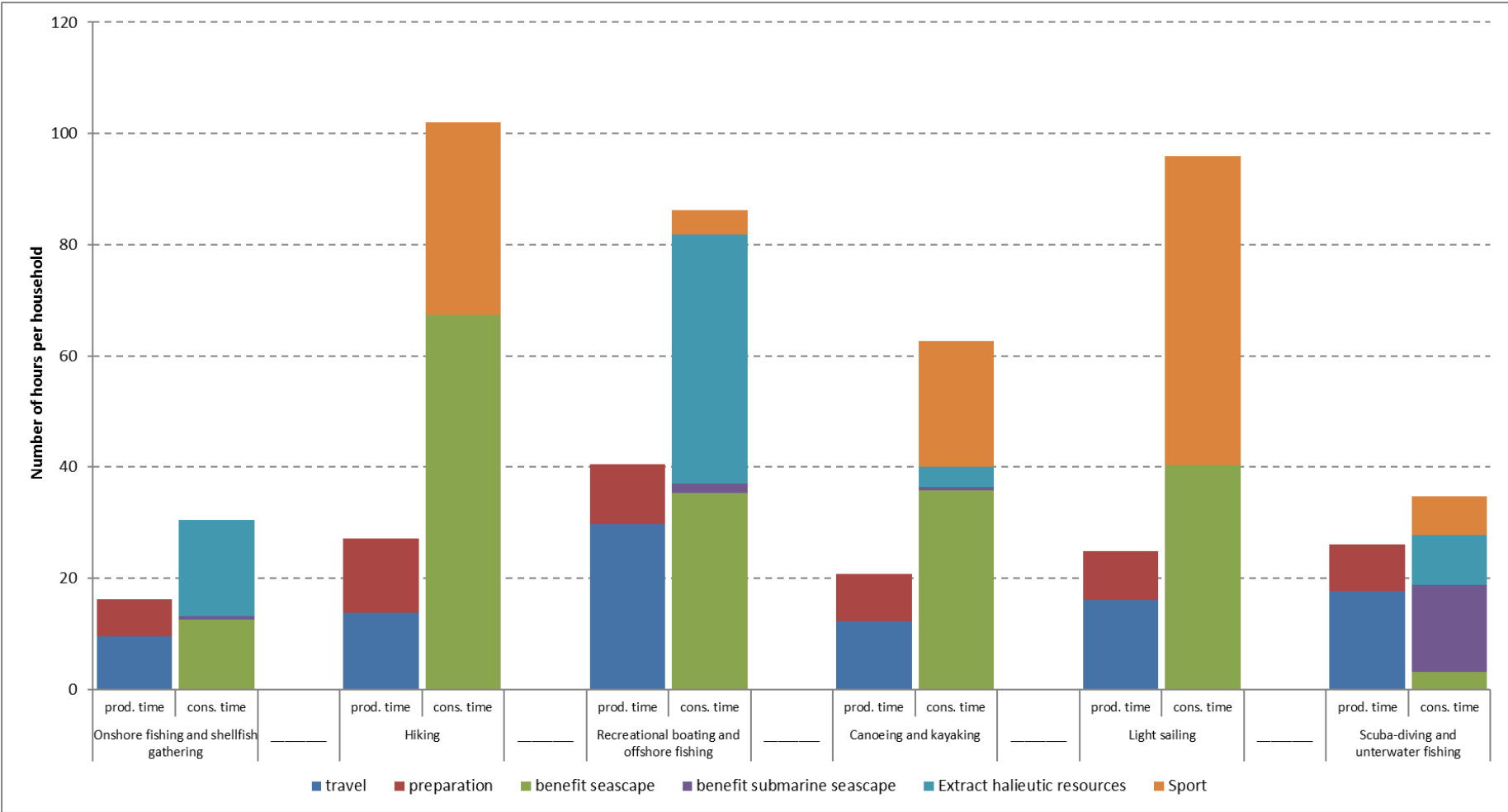


\*  $\alpha$  is the coefficient which is to be applied to the total production value for estimating the production value of cultural ecosystem services, with  $0 \leq \alpha \leq 1$

Figure 3: the map of the Gulf of Saint-Malo



Figure 4: Synthesis of production and consumption time for recreational activities





## List of tables

Table 1: Comparison of the sample structure and the population structure

		Sample	Population
<b>PROFILE OF INDIVIDUALS</b>			
Sex	Man	48.95%	48.65%
	Woman	51.05%	51.35%
Age	- 18	23.65%	22.04%
	18-24	6.69%	8.32%
	25 – 39	16.93%	17.87%
	40 - 54	21.31%	20.25%
	55 - 64	13.19%	12.84%
	65 and +	18.23%	18.69%
Status	Employee	41.13%	41.30%
	Pensioner	24.89%	24.53%
	Other	33.98%	34.17%
<b>PROFILE OF HOUSEHOLDS</b>			
Size of households	1	28.54%	34.86%
	2	35.80%	34.48%
	3	11.58%	12.71%
	4 and more	24.09%	17.94%
Age of family head	- 40	20.76%	27.84%
	40-54	29.34%	26.92%
	55 and +	49.90%	45.24%

Table 2: penetration rates and the number of households and individuals consuming recreational services produced by themselves

Activities	Households		Individuals	
	Penetration rate	Number of households	Penetration rate	Number of individuals
Onshore fishing and shellfish gathering	17,58 %	161,800	14,08 %	303,800
Hiking	13,24 %	121,900	11,33 %	244,400
Recreational boating and offshore fishing	7,00 %	64,400	4,82 %	103,900
Canoeing and kayaking	3,26 %	30,000	2,46 %	53,100
Light sailing	2,78 %	25,600	1,79 %	38,600
Scuba-diving and underwater fishing	2,66 %	24,500	1,40 %	30,300
<b>TOTAL</b>	<b>29,51 %</b>	<b>271,700</b>	<b>24,69 %</b>	<b>532,700</b>

Table 3: The framework in which households carried out recreational activities

	Personal context	Associations	Companies	TOTAL
Onshore fishing and shellfish gathering	99 %	0.4 %	0.4 %	100 %
Hiking	88 %	10 %	1 %	100 %
Recreational boating and offshore fishing	93 %	4 %	3 %	100 %
Canoeing and kayaking	78 %	17 %	5 %	100 %
Light sailing	73 %	26 %	2 %	100 %
Scuba-diving and underwater fishing	84 %	16 %	0 %	100 %

Table 4: Estimate of average consumption time for recreational activities by the household that undertakes the activity

	Frequency (per year) (A)	Duration (B)	Number of individuals per household (C)	Average time (per year) (D=A×B×C)
Onshore fishing and shellfish gathering	5.18 times	3h17'	1.8	30h37'
Hiking	14.47 times	3h40'	1.9	100h48'
Recreational boating and offshore fishing	10.65 times	4h46'	1.7	86h18'
Canoeing and kayaking	9.77 times	3h47'	1.7	62h50'
Light sailing	15,27 times	4h29'	1.4	95h50'
Scuba-diving and underwater fishing	8,55 times	3h23'	1.2	34h42'

Table 5: Part of consumption time devoted to the consumption of recreational services

	To benefit seascape	To benefit submarine seascape	To extract halieutic resources	To make sport	TOTAL
Onshore fishing and shellfish gathering	41 %	2 %	57 %		100 %
Hiking	66 %			34 %	100 %
Recreational boating and offshore fishing	41 %	2 %	52 %	5 %	100 %
Canoeing and kayaking	57 %	1 %	6 %	36 %	100 %
Light sailing	42 %			58 %	100 %
Scuba-diving and underwater fishing	9 %	45 %	26 %	20 %	100 %

Table 6: Production time per household per activity practised

	Preparation time (per year) (A)	Travel time (per year) (B)	Production time (per year) (C=A+B)
Onshore fishing and shellfish gathering	9h30'	6h42'	16h12'
Hiking	13h42'	13h24'	27h06'
Recreational boating and offshore fishing	29h42'	10h48'	40h30'
Canoeing and kayaking	12h11'	8h36'	20h47'
Light sailing	16h00'	8h48'	24h48'
Scuba-diving and underwater fishing	17h42'	8h24'	26h06'

Table 7: The supply/use tables for recreational activities: scenario A

Supply table (in M€)

Recreational marine activities Products of recreational marine activities	Onshore fishing and shellfish gathering	Hiking	Recreational boating and offshore fishing	Canoeing and kayaking	Light sailing	Scuba-diving and underwater fishing	Total production
<b>To benefit from the seascape</b>	16.125	33.599	32.171	7.063	6.841	1.098	96.897
<b>To benefit from the submarine seascape</b>	0.787		1.569	0.252		5.491	8.099
<b>To extract halieutic resources</b>	22.418		40.802	0.757		3.172	67.150
<b>To consume sportive services</b>		17.308	3.923	4.540	9.446	2.440	37.659
<b>Total production</b>	39.330	50.907	78.466	12.612	16.287	6.721	209.804

Use table

Recreational marine activities Economic products	Onshore fishing and shellfish gathering	Hiking	Recreational boating and offshore fishing	Canoeing and kayaking	Light sailing	Scuba-diving and underwater fishing	TOTAL
<b>Intermediate consumption of products (in M€) (A)</b>	13.852	19.231	37.905	4.438	7.663	5.48	<b>88.57</b>
<b>Remuneration of unpaid work (in M€) (B)</b>	24.718	31.152	24.595	5.884	5.987	6.03	<b>98.366</b>
<b>Consumption of fixed capital (in M€) (C)</b>	0.76	0.524	15.966	2.29	2.637	0.691	<b>22.869</b>
<b>Gross added value (D=B+C)</b>	25.478	31.676	40.561	8.174	8.624	6.721	<b>121.235</b>
<b>Production (in M€) (E=A+D)</b>	39.33	50.907	78.466	12.612	16.287	6.721	<b>209.804</b>
<b>Labour input (in FTE) (F)</b>	1.726	2.175	1.717	411	418	421	<b>6.867</b>

Table 8: The supply/use tables for recreational activities: scenario B

Supply table

Recreational marine activities Products of recreational marine activities	Onshore fishing and shellfish gathering	Hiking	Recreational boating and offshore fishing	Canoeing and kayaking	Light sailing	Scuba-diving and underwater fishing	TOTAL
<b>To benefit from the seascape</b>	22.907	47.356	38.919	9.268	8.523	1.461	128.434
<b>To benefit from the submarine seascape</b>	1.117		1.898	0.331		7.306	10.653
<b>To extract halieutic resources</b>	31.846		49.361	0.993		4.221	86.421
<b>To consume sportive services</b>		24.396	4.746	5.958	11.770	3.247	50.117
<b>TOTAL</b>	55.870	71.752	94.924	16.550	20.293	16.236	275.625

Use table

Recreational marine activities Economic products	Onshore fishing and shellfish gathering	Hiking	Recreational boating and offshore fishing	Canoeing and kayaking	Light sailing	Scuba-diving and underwater fishing	TOTAL
<b>Intermediate consumption of products (in M€) (A)</b>	13.852	19.231	37.905	4.438	7.663	5.48	<b>88.57</b>
<b>Remuneration of unpaid work (in M€) (B)</b>	41.257	51.997	41.053	9.822	9.993	10.065	<b>164.187</b>
<b>Consumption of fixed capital (in M€) (C)</b>	0.76	0.524	15.966	2.29	2.637	0.691	<b>22.869</b>
<b>Gross added value (D=B+C)</b>	42.017	52.521	57.019	12.112	12.63	10.756	<b>187.056</b>
<b>Production (in M€) (E=A+D)</b>	55.87	71.752	94.924	16.55	20.293	16.236	<b>275.625</b>
<b>Labour input (in FTE) (F)</b>	1.726	2.175	1.717	411	418	421	<b>6.867</b>