2019
03

Working Paper

INSTITUTO DE POLÍTICAS Y BIENES PÚBLICOS (IPP)

UNCOVERING THE HIDDEN ECOSYSTEM SERVICES EMBEDDED IN ENVIRONMENTAL INCOMES: TESTING EXPERIMENTAL EXTENDED ACCOUNTS IN *DEHESAS* OF HOLM OAK WOODLANDS, ANDALUSIA-SPAIN

Pablo Campos, Alejandro Álvarez, Bruno Mesa, José L. Oviedo, Paola Ovando, Alejandro Caparrós

INSTITUTO DE POLÍTICAS Y BIENES PÚBICOS – CSIC

Instituto de Políticas y Bienes Públicos
Consejo Superior de Investigaciones Científicas
C/ Albasanz, 26-28
28037 Madrid (España)

Tel: +34 91 6022300
Fax: +34 91 3045710

http://www.ipp.csic.es

How to quote or cite this document:

Campos, P. Álvarez, A., Mesa, B., Oviedo, J.L., Ovando, P. & Caparrós, A.. (2019) Uncovering the hidden ecosystem services embedded in environmental incomes: Testing experimental extended accounts in *dehesas* of holm oak woodlands, Andalusia-Spain. Instituto de Políticas y Bienes Públicos (IPP) CSIC, Working Paper. 2019-03.

Available at: digital.csic.es

Uncovering the hidden ecosystem services embedded in environmental incomes: Testing experimental extended accounts in *dehesas* of holm oak woodlands, Andalusia-Spain

Pablo Campos[1,*], Alejandro Álvarez[1], Bruno Mesa[1], José L. Oviedo[1,2], Paola Ovando[1,3], Alejandro Caparrós[1]

[1]Spanish National Research Council (CSIC)-Institute of Public Goods and Policies (IPP). [2]Spanish National Research Council (CSIC)- Institute of Marine Sciences of Andalusia (ICMAN). [3]James Hutton Institute.

*Corresponding author: pablo.campos@csic.es. Tel.: +35-91-602-2535. Spanish National Research Council (CSIC), Institute of Public Goods and Policies (IPP), C/ Albasanz, 26-28. E-28037 Madrid, Spain.

Highlights

Extended accounts dehesas´ environmental asset is 84% of total opening capital.
Farmer extended accounts dehesas´ share the 61% of total environmental asset.
Extended accounts dehesas´ ecosystem services are 45% of final product consumed.
Standard accounts' ecosystem services are 34% of extended accounts'.

Abstract

The ultimate goal of scholars and governmental institutions is to demonstrate nature in standard statistics, leading government agendas to the development of environmental-economic accounts which uncover hidden actual ecosystem services embedded in goods and services consumed by humans. In regards to physical and economic sustainable natural resource use, which lies beyond actual ecosystem services estimation, the potential sustainable ecosystem services indicator is a useful tool for nature conservation´s design and implementation. This indicator is defined as the environmental-economic reference for sustainable natural resource use. This research proposes that the potential sustainable ecosystem service indicator is the environmental income as measured by the extended accounts in this research. Our objective here is to compare the extended and the refined standard accounting frameworks' estimates ecosystem services and environmental incomes, applying producer, basic and social prices. The accounting frameworks are applied in case studies of sixteen large *dehesas* of holm oak woodlands in Andalusia, Spain. We measure seven farmers and six government *dehesas*' individual ecosystem services and environmental incomes. The *dehesas'* refined standard accounts ecosystem services and environmental incomes results at basic prices are, respectively, 0.4 and 0.1 times of those of the values measured by the extended accounts at social prices.

Keywords: Intermediate services, total income, net value added, environmental asset, change of environmental net worth, standard national accounts.

List of contents:

1. Introduction

The debate on economic ecosystem services from the perspective of its integration into a refined System of National Accounts (henceforth refined standard accounts) is currently an ongoing issue in the governmental agenda (Atkinson and Obst, 2017; Campos et al., 2019; Edens et al., 2013; Costanza et al., 2017; Obst et al., 2016; ONS, 2017; United Nations et al. 2014a, 2014b; United Nations, 2017; World Bank, 2016). Although the United Nations and the European Commission have recommended a further integration of such ecosystem services on the part of the member states, the fact is that such regulation still does not exist (United Nations, 2012; European Commission, 2011, European Union, 2011). The standard System of Environmental Economic Accounting-Central Framework (SEEA-CF) and the still-in-process satellite Experimental Ecosystem Accounting (SEEA-EEA) constitute the current governmental conceptual development of the environmental asset balance and ecosystem services measurements linked with the standard accounts (European Commission et al., 2009; FAO, 2017; ONS, 2017; United Nations et al., 2014a, 2014b; United Nations, 2017). Currently, the European Commission is promoting the 'Knowledge Innovation project on an integrated system of Natural Capital and ecosystem services Accounting (KIP-INCA)' which is aimed towards reaching a statistical offices consensus protocol for ecosystem services accounting inside and, potentially, beyond the standard accounts' prices and economic activities boundaries (Eigenraam and Obst, 2018; European Commission, 2016; Haines-Young and Potschin, 2013; La Notte et al., 2017, 2019a, 2019b; Ogilvy et al., 2018; Maes et al., 2016).

Few articles have applied the economic concept of ecosystem services from the perspective of their integration into refined standard and extended accounts. Several authors have incorporated new products without market prices omitted by the standard accounts in the territorial unit, to which simulated transaction prices are imputed, and in other products with and without market prices from activities outside the examined territorial unit (water supply use in irrigated land). (Remme et al., 2015; Sumarga et al., 2015; EFTEC, 2015; Keith et al., 2017; Campos et al., 2017, 2019).

In our research, we applied the definition of economic ecosystem services in accordance with the SEEA-EEA guidelines and referred to their potential residual value embedded in the economic products consumed by people during the accounting period (Campos et al., 2017, 2019; United Nations, 2017). This research broadens the scope of the standard accounts products, non-market valuation criteria and gross value added boundaries by

applying the extended Agroforestry Accounting System (henceforth extended accounts). The latter had been applied in previous published research on Spanish *dehesas,* Californian ranches and Andalusian forests (Campos et al., 2008, 2013, 2016, 2017, 2019; Caparrós et al., 2017; Ovando et al., 2016; Oviedo et al., 2017). The environmental income as the upper potential value reference for sustainable ecosystem services value is experimentally applied applying the extended and refined standard accounts to holm oak *dehesa* case studies in Andalusia, Spain. The *dehesa* case studies' economic variables are gathered from eleven farmer-based and seven government economic activities

We measure the individual and aggregated economic activities' total income and total capital by applying extended and refined standard accounts to sixteen non-industrial, privately-owned holm oak properties as case studies (henceforth *dehesas*) in Andalusia, Spain.

Our objectives are twofold: first, to estimate total income, actual ecosystem services and environmental income, and second, to compare extended and refined standard accounts actual ecosystem services, gross value added and environmental income.

2. *Dehesa* case studies institutional setting and accounting frameworks

This section does not include details of the multiple primary data measurements and valuation methods since these have been described in several publications (Campos et al., 2016, 2017, 2019; Caparrós et al., 2017; Ovando et al., 2016; Oviedo et al., 2017). Nevertheless, specific accounting and valuation criteria applied in these *dehesa* case studies have been briefly depicted below and in the supplementary materials.

2.1 Dehesa case studies institutional setting

2.1.1 Andalusian government *dehesa* definition

The Andalusian government define the *dehesa* as a spatial unit property "constituted for the most part by open woodland, subject to a system of land use and management based mainly on extensive livestock that uses grass, non-industrial fruits and browses, as well as other forestry, hunting or agricultural uses" (BOJA, 2010: 4, article 2b). *Dehesa* open woodland is a "forested land occupied by a tree stratum, with a canopy cover fraction (soil surface area covered by the projection of the tree crowns) of between 5% and 75%, mainly comprising of holm oaks, cork oaks, Portuguese oaks or wild olive trees, and occasionally

other types of trees, which allow the development of a herbaceous stratum, which can be utilized by livestock or hunting species" (BOJA, 2010: 4, article 2a).

2.1.2 Micro extended accounts applications to holm oak *dehesas* in Andalusia

This micro scale application to holm oak *dehesa* case studies (16 farms and 9,032 ha) are a small portion of the Andalusian region holm oak woodlands (1,408,170 ha). The SEEA-EEA, while not excluding micro spatial application, has so far focused on discussions of methods and applications at the macro scale (a regional or national scale of forest and silvo-pastoral ecosystems). Our micro scale extended accounts application to the *dehesas* is intended to be an experimental development of model B of the SEEA-EEA. Not yet having an explicit development at micro scale of the SEEA-EEA, it is justified that we summarily explain the application in the holm oak *dehesas* in comparison with other previous applications of the extended accounts at farm and regional scales (Campos et al., 2017, 2019; Ovando et al., 2016).

The extended accounts concept and methods of ecosystem services and environmental assets are the same whatever the scale of applications might be. The macro-scale we applied to the cork oak forests of Andalusia did not incorporate the results of the hunting, nor livestock and crops activities (the latter is a negligible activity) (Campos et al., 2019). On the other hand, the micro-scale results of a sample of Andalusian *dehesas* do incorporate these activities omitted from the regional application (Ovando et al., 2016).

Why do animal activities matter in the case of estimates of the values of ecosystem services on a regional scale? Animal activities matter because our extended accounts application of social prices to case studies of holm oak *dehesas* and holm oak woodlands in Andalusia both incorporate government compensation and opportunity costs incurred by owners in the management of hunting, livestock and crops activities. Compensation and opportunity costs are registered twice, first, as intermediate products of hunting, livestock and crops activities and after, as own non-commercial intermediate consumptions of services (SSnco) of private amenity and landscape conservation activities. These SSnco influence the ecosystem service estimates of the amenity and landscape activities. The ES incorporates the final animal products consumed which has been measured by the hunting environmental activity (as an environmental value substitute for game not paid environmental grazed fodder) and grazing paid for livestock activity.

The nearest partial precedent for the forest farms application of extended accounts at social prices is Campos et al. (2017). This publication applies extended accounts to

commercial activities and does not estimate the value of ecosystem services from public goods and services, other than carbon. This extended account's new application in a sample of holm oak *dehesa* case studies incorporates such valuations of ecosystem services and environmental incomes at social prices.

The relevance of farm scale applications should be that in order to avoid the ES overvaluation bias estimate at producer price (Campos et al., 2019: 234), we should estimate ES at social price. Therefore, the extended accounts macro-scale application of the holm oak woodlands in Andalsia requires estimates of the SSnco from government compensations and opportunity costs incurred voluntarily by owners.

2.1.3 Economic activities and institutional sectors

The economic ecosystem services and environmental income accounting aim for consistent integration of refined standard and extended accounts applications as production factor of intermediate and final products into *dehesas*. The concept of economic ecosystem service applied here does not detract from that of ecosystem services in ecology, as the challenge is more to uncover the ecosystem services and the environmental incomes that contribute to the total products and assets of *dehesas* multiple private and government economic activities (Campos et al., 2016, 2017, 2019; Ovando et al., 2016; Oviedo et al., 2017). Thus, we do not follow the model A supply and use tables of the SEEA-EEA that give nature the condition of being an instrumental independent institutional sector. We believe that nature considered as a production factor and being integrated into farmer and government economic activities is more intuitive and has the advantage of direct integration in the actual standard accounts structure and properties rights. Therefore, we prefer to develop and testing the model B of the SEEA-EEA (United Nations et al., 2014b: Annex 6.1, Table 6.1, p. 144; United Nations, 2017: Table 8.2, p. 135).

These *dehesa* case studies consider the institutional sectors of farmer and government. The farmer is responsible for the management of their own private activities. We adopt a definition of public goods and services that is restricted to the requirement that their consumption and appropriation should be free to beneficiaries. This concept goes beyond the narrower definition of pure public goods (Maler et al., 2008). According to this definition of public product (good or service), it follows that the government regulates and compensates the economic activities of farmers and directly manages public activities. These *dehesa* case studies incorporate the gathered data from eleven farmers and seven government economic activities. *Dehesas* farmer activities incorporate timber, cork, firewood, pine nuts, grazing

(acorn, grass, browse and other minor grazed fodder), forestry conservation services, hunting, livestock, agricultural crops, residential house services, commercial recreation services and amenity auto-consumed services. Government activities include fire services, free-to-access mushroom gathering, the public free access recreation, water runoff, carbon service, landscape conservation services and threatened wild biodiversity services.

Households are considered as an independent economic unit in the standard accounts, whereas in this *dehesas* refined standard and extended accounts applications the public recreational free-access services and mushroom collections are considered to be produced by the two respective governmental activities (Campos et al., 2019; European Commission et al., 2009).

2.1.4 Data sources

The research extended accounts application to *dehesas* had required data from the third National Forestry Inventory in Andalusia, which modeled data for tree and hunting species at *dehesas* sites in the form of biological growth functions for work in progress products (woody plant and hunting species), intermediate product and own intermediate consumption, and market cost data by individual activity and their products. Additional points of data at different scales beyond the *dehesas* sites include macro geo-referenced data regarding government spending and surveys of consumers' willingness-to-pay for the consumption of public non-market products. Therefore, in the extended accounts application, the single *dehesa* is the independent economic unit, where it is possible to measure the economic value of an individual product and its economic interactions among other *dehesa* activities by the measurement of intermediate consumption. The primary single *dehesa* data is the starting point for gathering the information on production, consumption, gross capital formation and change of environmental net worth, which allows to estimate *dehesas* physical and economic indicators (Campos et al., 2017, 2019).

2.1.5 Scheduled sustainable physical and economic future *dehesas* managements

When applying the extended accounts to *dehesas*, we estimated the closing environmental assets according to the scheduled future sustainable physical and economic *dehesa* management. We make four assumptions concerning scheduled future *dehesa* management: (i) the current management is maintained in the future without technical innovation; (ii) the physical productivity of the natural resources will change with the biological modeling functions; (iii) in the case of trees (i.e., timber, cork, firewood and

acorns), shrub and hunting products, it is forecasted that the current biological cycle of the trees and shrubs will be followed by further cycles of regeneration (either natural or induced by human intervention) and enough hunting births to guarantee indefinite persistence in the condition of the biotic environmental assets, and (iv) the absence of irreversible losses of biological or cultural assets in the *dehesa* case studies (Campos et al., 2017, 2019).

2.2. Brief depict of extended accounts concepts applied to dehesa case studies

The concepts and methods of extended accounts have been applied in previous publications of the authors in Campos et al. (2016, 2017, 2019), Caparrós et al. (2017), Ovando et al, (2016) and Oviedo et al. (2017). In this article we briefly describe the most novel aspects applied in the *dehesa* case studies in order to facilitate readers' comprehension of the text without a need to turn to published literature. The figures and tables of results of and the supplementary texts present exhaustively ordered the links of the elements that make up the results of the estimated economic variables.

2.2.1 Intermediate product

The total product consumed from the case studies of *dehesas* contains the double counting of the intermediate product because it is also embedded in the final product consumed. The reason why the intermediate product must be accounted for is because it is indispensable for estimating the net operating margins of the individual activities of the single *dehesa* (independent basic economic enterprise).

Both standard and extended accounts measure *dehesa* case studies conservation forestry, residential and fire services activities produce commercial intermediate services (ISSc) and compensated non-commercial intermediate services (ISSncc) paid by government to favour the supply of public products. In addition of ISSc and ISSncc, in these *dehesa* case studies, we assume that the farmer assumes risks associated with manufactured (man-made) capital investment decisions and accepts ex-ante voluntarily to incur in monetary opportunity costs (Raunikar and Buongiorno, 2006). The farmer opportunity cost is defined as the equivalent monetary benefit that the farmer voluntarily gives up from the manufactured investment in the commercial activities of her/his farm in exchange for a greater family auto-consumption expected from private amenities (Oviedo et al., 2017). It is assumed in these *dehesa* case studies that the farmer's (owner) monetary opportunity costs incurred in the accounting period generate a supply here named auto-consumed non-commercial intermediate services (ISSnca). The ISSnca is estimated by the difference between the normal ordinary

manufactured net operating margin (NOMmon) and the ordinary manufactured net operating margin at basic price ($NOMmo_{bp}$) of the individual activities of conservation forestry, livestock and hunting activities in exchange for a higher consumption level of private amenities (Masiero et al., 2019: p. 52). Thus, the ISSnca has the accounting counterpart in the own auto-consumed non-commercial intermediate consumption of services (SSncoa) in the cost side of the private amenity activity (for details see Supplementary text S1).

2.2.2 Social price

The value of a product contains embedded the individual values of its total production costs and net operating margin at social price. The social price of a product from the *dehesas* studied is defined as the sum of the basic price and the unit value of the intermediate amenity service (monetary opportunity cost unit accepted from the farmer). The basic price (price at factor cost) represents the producer price (market price) plus the unit value of the operating subsidies (government compensations) net of taxes on products.

The valuations of products at different prices do not influence estimates of the total farm gross value added. However, the different types of prices do influence the estimates of ecosystem services and the gross value added by the farmer and government, and those of the individual activities affected by the production of auto-consumed intermediate services and the ensuing auto-consumed intermediate consumption of services. Standard accounts estimate ecosystem services and gross value added at market and basic prices, and extended accounts add the total product measurement at social price (for details see Supplementary text S1).

2.2.3 Net value added

The extended net value added ($NVA_{sp,E}$) represents the production factors operating income contributions of labor cost (LCr) and total immobilized capital service (IMC), this service is called net operating margin ($NOM_{sp,E}$) in the accounting period. The $NOM_{sp,E}$ is estimated as the residual variable that within the production account, balances the total product with the total cost of the individual activities. The extended account's gross value added at social prices ($GVA_{sp,E}$) is estimated subtracting the intermediate consumption (IC) from the total product at social price (TP_{sp}). The net value added ($NVA_{sp,E}$) is obtained from the $GVA_{sp,E}$ minus the consumption of fixed capital (CFC):

$$NVA_{sp;E} = LCr + NOM_{sp,E} \quad \text{(Eq. 1)}$$

The aggregate full activities gross/net value added and operating margins at producer prices, basic prices and social prices of the nation, region territories or any spatial unit equate. This is not the case for farmer and government gross/net operating margins. Extended accounts replace the valuation of non-market public products at production cost of standard accounts with the marginal willingness to pay (simulated exchange value) of farmer and public consumers. The refined labor cost (LCr) of the standard accounts coincides with that of the extended accounts, and the respective operating surplus and margin differ.

2.2.4 Total income

The total social income (hereinafter total income) represents the maximum potential consumption of products of the *dehesas* which keeps constant the real value of total capital at the closing of the accounting period compared with its value at the time of opening (European Communities, 2000).

The total income (TI) is the variable on which we base the structures of extended production and capital balance accounts of farmer, government and farm single activity, and its factorial distribution across labor, manufactured capital and environmental assets. In extended and standard accounts, total income (TI) primary accounting identity contains the net value added (NVA) and the capital gain (CG) [1]. The CG is made up of the revaluation (Cr) minus the withdrawal for extraordinary destruction (Cd) of the capital account and plus the instrumental adjustment which avoids double counting (Cad) (Campos et al., 2017, 2019; McElroy, 1976):

$$TI = NVA + CG \quad \text{(Eq. 2)}$$

$$NVA = NOM + LC \quad \text{(Eq. 3)}$$

$$CG = Cr - Cd + Cad \quad \text{(Eq. 4)}$$

After measuring this first TI identity, it could be used to derive other two accounting identities. Thus, a second TI identity is directly related to consumption (total product consumption minus intermediate consumption) and change in net worth. A third TI identity shows its factorial allocation across labor costs (LC) and capital income (CI), which is the sum of manufactured capital income (CIm) and the environmental income (EI):

[1] Standard accounts only incorporate the measurement of livestock capital gain into total income. In contrast, the revised standard accounts do incorporate all capital gains from the farmer's commercial products and the government's manufactured fixed capital.

$$TI = TPc - IC + CNW \quad \text{(Eq. 5)}$$

$$TI = LC + CIm + EI \quad \text{(Eq. 6)}$$

The three total income accounting identities described above present singularities of interest for estimates of ecosystem services and environmental income.

2.2.5 Economic actual ecosystem services

Statistical institutions have stated "that flows of ecosystem services should be clearly differentiated from the goods and services that are produced [with manufactured capital]. Thus, the ecosystem services represent the contribution of ecosystem [environmental] assets to the production of those goods and services" [products] (United Nations, 2017: p. 75). This SEE-EEA perspective delimits the ecosystem services potentially embedded in the intermediate and final products consumed from the standard accounts in the first real or simulated transaction of the product, although it is still discussed whether they could be extended with additional products to those now included in the standard accounts in future government methodology of satellite standard ecosystem accounts.

In this *dehesas* research, the actual ecosystem services (ES) represent the natural gift embedded in the total product consumed direct or indirectly by human in the accounting period produced with and without manufactured immobilized capital in each individual spatial unit (*dehesa* property) and single activity (for details see Supplementary text S2). Therefore, in general the ecosystem services are residual values embedded in the total product consumed (TPc) (Eq. 7). The ES potential nature gift components in the Eq. 7 are the opening period utilized environmental work in progress (WPeu) and the ordinary environmental net operating margin (NOMeo) (Eq. 8):

$$TPc = ICmo + WPeu + LCo + CFCmo + NOMmo + NOMeo \quad \text{(Eq. 7)}$$

$$ES = WPeu + NOMeo \quad \text{(Eq. 8)}$$

$$ES = TPc - ICmo - LCo - CFCmo - NOMmo \quad \text{(Eq. 9)}$$

$$NOMmon = r*IMCmo \quad \text{(Eq. 10)}$$

where ICmo is ordinary manufactured intermediate consumption, LCo is ordinary labor cost, both employees and self-employed, CFCmo is ordinary manufactured consumption of fixed capital, NOMmo is ordinary manufactured net operating margin, r is normal profitability rate and IMCmo is ordinary manufactured immobilized capital (Campos et al., 2017, 2019).

This research assumes that there are no ecosystem services negative values. However, this research admits the short-term exception of the potential existence of negative ecosystem services of products in which their production functions use their own intermediate consumption as the only manufactured cost (e.g., private amenity activity).

The SEEA-EEA literature maintains the debate on whether negative ecosystem services can exist beyond the short term (Obst et al., 2016; Costanza et al., 2017; Campos et al., 2019). The difficulty of distinguishing the flows of ecosystem service, environmental intermediate consumption and consumption of environmental fixed capital embedded in products in the production function concurs in this discussion.

The total product consumed (Eq. 7) does not inform on the natural growths accumulated at the closing (NG) of the accounting period in the *dehesas*, the consumption of environmental fixed asset (SSe) and the environmental asset gain (EAg). Thus, actual ecosystem services have no direct link with the spatial unit economic sustainable ecosystem services (ES), except when the value of the environmental work in progress used (WPeu) to change of environmental net worth (CNWead) is zero (for details see Supplementary text S1).

2.2.6 Environmental asset

Total capital (C) represents the aggregate market values (observed and simulated) of environmental assets and manufactured capital (the latter produced by human intervention) used during the accounting period to obtain the total product consumption and the gross capital formation of the economic activities of the farmer (which includes both the landowner and livestock keeper) and the government in the *dehesa* case studies.

Opening total capital (Co) consists of environmental asset (EAo) and manufactured capital (Cmo)[2]. The EAo is valued according to the discounted future resource rents (RR) (United Nations et al., 2014a). In this case studies a normal discount rate of 3% is accepted. Thus, the EAo represents the discounted exchange value of future expected products consumed quantity (q_c) times environmental prices (ep) (Campos et al., 2017, 2019). The latter price is defined as the stumpage price less unitary manufactured total cost and normal return. In other words, environmental price is the resource rent price. The standard SEEA-CF only estimates the environmental asset of commercial products. The exceptions in these *dehesas* research to the use of the net present value (NPV) in the calculation of the individual environmental assets are for amenity and water environmental assets. The amenity

[2] The opening manufactured capital (Cmo) is estimated considering its market replacement corrected by a coefficient that denotes its state of conservation (Campos et al., 2019).

environmental asset is estimated as the share of the market price of the land corresponding to the private amenity stated by the farmer and by modeling the land function price (Campos et al., 2019; Oviedo et al., 2017). The water environmental asset is estimated by the water hedonic price shared of irrigated land market price (Campos et al., 2019).

The EAo is classified between environmental work-in-progress (WPeo) and fixed environmental assets (EFAo). The WPeo are the natural growths[3] of the biota produced (opening inventory) and expected to be produced in the spatial unit for future consumption, and they are valued by their discounted environmental prices according to the remaining accounting periods until the period in which they are harvested (Campos et al., 2017, 2019). The discounted natural growths of biota that accumulate in the spatial unit destined for the production of future environmental flows (produced at opening accounting period and expected to be produced in successive periods) are termed opening environmental fixed assets of biological resources (EFAbro). Besides the woody biota, EFAo also include expected future run-off surface water stored in watershed downstream governmental reservoirs, expected future collection of mushrooms and the expected future flows of public recreation, landscape and biodiversity services consumption valued by their discounted environmental prices (Campos et al., 2017, 2019):

$$RR = q_c * ep \quad \text{(Eq. 11)}$$

$$EAo = \sum_{s=t}^{\infty} \frac{RR}{(1+r)^{(s-t)}} \quad \text{(Eq. 12),}$$

where r is the normal discount rate, s is the year of consumption of the natural resource and t is the actual accounting period.

2.2.7 Environmental income

The environmental income (EI) represents the free contribution of nature to total income. The extended and refined standard accounts EI accounting components are the environmental net operating margin (NOMe) and the environmental asset gain (EAg) (Campos et al., 2017, 2019). After arranging the original EI accounting identity (Eq. 13), a second EI identity is estimated showing the link between actual ecosystem service and the scheduled sustainable environmental asset. Thus, the EI is defined as the maximum potential consumption of actual ecosystem services so that they will avoid negative adjusted change of

[3] The natural growth of WPe in the accounting period is termed environmental gross work in progress formation (GWPFe).

environmental net worth (CNWead) in the accounting period, giving a necessary scheduled management of sustainable ecosystem services consumption (Campos et al., 2019). From Eq. 14 it follows that environmental income can be defined as the maximum potential sustainable economic actual ecosystem service that could be consumed in the accounting period while maintaining the CNWead equal to zero (for details see Supplementary text S1):

$$EI = NOMe + EAg \quad \text{(Eq. 13)}$$

$$EI = ES + CNWead \quad \text{(Eq. 14)}$$

2.3 Linking refined extended accounts with standard accounts

The *dehesa* case studies' extended accounts net operating margin at social prices ($NOM_{sp,E}$) regarding refined net operation surplus at basic prices ($NOSr_{bp,S}$) of the standard accounts are differentiated by the incorporation to the first of the auto-consumed intermediate service (ISSnca), the final service of carbon fixation (FPca), the natural growth (NG), the own auto-consumed intermediate consumption of amenity service (SSncoa), the environmental work in progress used (WPeu), the carbon consumption of environmental fixed asset (SSe), and the increase of the prices of the final private amenity service (ΔFPpa) and the final public goods and services (ΔPGS) of water, recreation, landscape and biodiversity (for details see Supplementary text S3):

$$NOM_{sp,E} = NOSr_{bp,S} + ISSnca + FPca + NG - SSncoa - WPeu - SSe + \\ + \Delta FPpa + \Delta PGS \quad \text{(Eq. 15)},$$

where subscript E is extended accounts, subscript Sr is refined standard accounts, subscript bp is basic prices and subscript sp is social prices.

Taking into account Eq. 16 (for details see Supplementary S3), the *dehesas* $NOM_{sp,E}$ is estimated while considering the refined standard accounts net operating margin at basic prices ($NOM_{bp,Sr}$):

$$NOSr_{bp,S} = NOMr_{bp,S} + WPeu \quad \text{(Eq. 16)}$$

$$NOM_{sp,E} = NOM_{bp,Sr} + ISSnca + FPca - SSnca - SSe + \Delta FPpa + \Delta PGS \quad \text{(Eq. 17)}$$

3. Holm oak *dehess* case studies physical and economic results and discussion

3.1 Spanish and Andalusian dehesas size and surface

Spanish *dehesas* cover a total area of 3,606,154 ha and their open woodlands account for 2,203,002 ha (Campos et al., 2017: Table 2, p. 3 and Fig. S9, p. 33). The natural conditions and historical process of land appropriation have led to the concentration of most of the *dehesas'* surface in large properties. There are 4,575 Spanish *dehesas* properties of 200 ha or more sharing the 64% of the Spanish *dehesas* area, and with an average property size of 502 ha. There are 107,812 *dehesas* properties with less than 200 ha that have an average size amongst them of 12 ha (Campos et al., 2017: Table 2, p. 3). Andalusia has 1,099 *dehesa* properties of 200 ha or more with a total area of 505,105 ha, which represents 68% of the total area occupied by *dehesa* properties in Andalusia (MAPA, 2008, Table 18, p. 44).

These case studies of holm oak *dehesas* show the diversity of natural environments in which holm oaks are present and dominate the landscape in Andalusia (Fig. S1). The average property size of these *dehesas* is 565 ha (Table 1), which is 1.2 times the average *dehesas* properties with sizes of 200 ha or more in Andalusia (MAPA, 2008, Table 18, p. 44). These *dehesas* land vegetations and uses account for 78% of open woodland while coniferous forests make up 8% of the land area (Table 1). Meanwhile, holm oaks comprise 90% of the open woodland area. Fractional canopy cover of these holm oak open woodlands is 34% (Table S1).

3.2 Holm oak dehesa case studies selected physical productive indicators

We briefly depict several biophysical indicators that aid in understanding the economic outcomes and describing indicators of natural growths and extractions of woody natural resources scheduled for the future. This reinforces our normative assumption that future management of biological resources is expected to be sustainable from an ecological perspective.

3.2.1 Labor demand

The *dehesas* generate one annual work unit (AWU)[4] for every 122 ha, with 89% being demanded by farmers and 11% by the government. Self-employed labor is only provided by the farmer and accounts for 23% of the farm man-hours. We estimate that 17% of the self-employed labor receives no monetary compensation, 77% of which is concerned with

[4] The annual work unit (AWU) is equivalent to a person employed full-time in the *dehesa* property who provides services for 1,826 hours per year (MAPA, 2010).

livestock activity, 18% with hunting activities and the rest with other activities (Table S2, Fig. S2). Livestock activity accounts for 45% and hunting activity represents 17% of the annual work-hours labor demand.

3.2.2 Natural growths and harvests

Physical natural growths and harvests indicators refer to the self-production area (Tables S3-S4). There is a small area with timber tree species with an average natural growth of 2.2 m^3/ha where no timber is harvested in the accounting period. Cork trees make up a small area growing 0.8 t/ha and stripping 0.3 t/ha. Holm oak firewood growth is 1.0 m^3/ha and pruning is 0.2 m^3/ha. Natural fodder grazing (grass, browse, acorns and other non-industrial fruits) by livestock as well as hunting species contributes, respectively, 13.8% and 86.2% to total grazing forage unit consumption of 520.2 FU/ha. This grazed natural fodder is shared by livestock and hunting species, respectively, 57.7% y 42.3%. The largest shares of hunted species are red deer and wild boars, with capture rates of 7.4 and 1.8 units per he/km^2, respectively. The opening inventory of female livestock is 15 units per he/km^2 while the equivalent cows stocking rate[5] is shared 73% by cows and 27% by sheep and goats. The *dehesas* also provided excellent nutrition for Iberian pigs (and other hybrid pig races) in eight case studies, which occurred in *montanera* season that represents 14% of total forage units grazed in the *dehesas*. Assuming that 70% of *monatenera* pig-grazed natural fodder comes from acorns consumed, then the latter accounts for 70% of total acorn grazed in *dehesas* (Tables S3-S4). Mushrooms gathered by public free access recreational visitors are foraged at a rate of 2.4 kg/ha. Recreational visitors visit at a rate of 1.6 visit/ha. Carbon net fixation by trees and shrubs occurs at a rate of 2.3 tCO_2/ha. There is one threatened species per 100 ha. Economic final water runoff is collected at a volume of 680 m^3/ha. 47.7 m^2 of farmer residential housing is constructed per hectare (47.7 m^2/ha). This commercial intermediate service amenity provides key infrastructure to enhance the farmer amenity auto-consumption.

3.3 Refined standard accounts results

Tables S5-S6 presents the measurements of ecosystem services acquired, net value added and environmental income of the refined standard accounts. We will now summarily describe our revision of the standard accounts that consists of having incorporated the values of (i) the compensated, auto-consumed and non-commercial intermediate services (ISSncc/a),

[5] Based on the daily maintenance requirement (kcal/day) of a non-pregnant reproductive female for cattle, sheep and goats (Martin *et al.*, 1987).

(ii) the natural growth (NG) in the own account gross capital formation (GCF), and (iii) the environmental work in progress used (WPeu) and the own non-commercial intermediate consumption of compensated and auto-consumed services (SSncoc/a) in the own intermediate consumption of services (SSo). Table S6 shows the lack, by comparison with the extended accounts, of carbon activity records, as the latter is not recognized in the *dehesa* case studies by the standard accounts. The only change at the *dehesa* scale between the measurements of the net value added by the standard accounts (SNA) and the refined standard accounts (Sr) is due to the subtraction of WPeu from NG. At the farm scale, the result of subtracting SSncoc/a from ISSncc/a is zero. However, this is not the case for the individual activities that are involved in the products and costs for the variables cited, as well as for the comparative estimates of the ES, NVA and EI for the owners and the government. Our interest is to focus only on the comparative results (and inherent differences) of the refined standard accounts and the extended accounts.

The manufactured capital from the extended and refined standard accounts is the same, as it is for environmental assets with market prices. Tables 2-S7-S8 show the values of environmental assets and manufactured capital at the opening and closing of the accounting period of the extended and refined standard accounts. The environmental assets excluded from the standard accounts are public final products consumed for recreation, carbon, landscape, biodiversity and water consumed within the economic system by non-agricultural users.

Table 1. Holm oak *dehesa* case studies vegetation covers and other land uses in Andalusia, Spain (2010).

Class	*Dehesa* D1	*Dehesa* D2	*Dehesa* D3	*Dehesa* D4	*Dehesa* D5	*Dehesa* D6	*Dehesa* D7	*Dehesa* D8	*Dehesa* D9	*Dehesa* D10	*Dehesa* D11	*Dehesa* D12	*Dehesa* D13	*Dehesa* D14	*Dehesa* D15	*Dehesa* D16	*Dehesas*	
	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	%
1. Useful agrarian land	178	738	2,009	1,258	186	286	464	207	302	356	286	313	1,312	708	76	297	8,974	99.4
1.1 Open woodland	178	660	1,821	568	63	102	301	191	294	286	256	245	1,159	632	64	249	7,066	78.2
Quercus ilex	178	583	1,821	381	63	102	234	186	294	278	201	231	1,032	574	64	139	6,361	70.4
Quercus suber		12		47			54	0		8			126	58		35	341	3.8
Others oaks		65		116			9					13					204	2.3
Wild olive				23			3	5			55					75	160	1.8
1.2 Eucalyptus				55			55	2			0						112	1.2
1.3 Shrubland [(1)]		0	120	62	0	46	43		1	49	4	4	83	37	11	10	471	5.2
1.4 Grassland		0	58		3	88	5		7	19	1	9	40	27	1	7	266	2.9
1.5 Coniferous	0	78	0	469	96	4	0	0	0	0	0	0	0	0	0	31	678	7.5
Pinus pinea		78		331			0										409	4.5
Pinus pinaster				138													138	1.5
Pinus nigra					1												1	0.0
Pinus halepensis					90	1											92	1.0
Others coniferous					5	3										31	39	0.4
1.6 Other forest[(2)]			1	34	0	29	37				2	39	30	12			185	2.0
1.7 Agricultural			9	70	24	17	23	14		0	23	16			1		196	2.2
2. Others [(3)]	1	2	2	3	0	0	3	4	4	0	9	1	24	2	0	2	58	0.6
3. Total	179	740	2,010	1,260	186	286	468	211	306	356	296	314	1,336	710	77	298	9,032	100.0

Notes: [(1)] Includes shrubland and shrubland and grassland. [(2)] Includes riparian forests, other species and mix oaks-conifers forests. [(3)] Infrastructure an unproductive surface.
Farm average size: 565 hectares.

3.4 Extended accounts economic results and discussion

We focus the analysis of the results on the economic valuations of the ecosystem services and environmental incomes of the individual activities of the case studies of *dehesas*. We began with the description and assessment of the results by fulfilling the extended production and capital balance accounts for the individual activity and the activities of farmers, the government, and *dehesas* of the 2010 accounting period (Tables 2-S7-S8-S9-S10-S11-S12). The results of the extended accounts are enough to subsequently make it possible to accurately measure the ecosystem services and the environmental incomes in the *dehesa* case studies.

After completing the records for extended production and capital account, the next steps in the analysis of economic results are as follows: (i) we show the composition of the opening total capital and highlight the predominance of environmental assets, (ii) we explain the accounting process leading to the estimation of ecosystem services and environmental income and, finally, (iii) we compare the extended and refined standard accounts results for ecosystem services, gross value added and environmental income at producer, basic and social prices.

3.4.1 Opening total capital

The extended accounts estimate *dehesas* farmer opening environmental assets contribution of 78% to total farmer opening capital (Tables 2-S7-S8-S9-S10). There are notable contrasts among the farmer individual activities environmental assets. Grass and acorn, respectively, contribute 35.2% and 2.7% to farmer commercial products environmental assets. Environmental assets of private amenity activity is 1.25 times higher than those of the farmer commercial products. Manufactured residential houses and livestock fixed investment respectively represent 31.3% and 46% of famer manufactured total fixed investment. As might be expected, the aggregated opening manufactured fixed capital of the farmer is 12.5 times higher than those of the government (Tables 2-S7-S8).

The farmer extended accounts environmental assets are 1.6 times than those of the government (Tables 2-S7-S8). The governmental extended environmental account assets are shared amongst water yield (representing 41.4% of such assets), public recreation (18.3%) and landscape environmental assets (12.6%) (Table 2-S7-S8).

Table 2. Holm oak *dehesa* case studies extended accounts opening capital in Andalusia, Spain (2010: €/ha)

Class	Opening environmental asset			Opening manufactured capital			Opening capital		
	Farmer	Government	Total	Farmer	Government	Total	Farmer	Government	Total
1. Timber	35.5		35.5	0.7		0.7	36.2		36.2
2. Cork	880.9		880.9	2.0		2.0	882.9		882.9
3. Firewood	165.4		165.4	1.8		1.8	167.2		167.2
4. Nuts	0.5		0.5				0.5		0.5
5. Grazing	923.7		923.7	64.3		64.3	988.0		988.0
5.1 Grass	*857.7*		*857.7*	*64.3*		*64.3*	*921.9*		*921.9*
5.2 Acorn	*66.0*		*66.0*				*66.0*		*66.0*
6. Conserv. forestry				10.1		10.1	10.1		10.1
7. Hunting	429.7		429.7	117.8		117.8	547.5		547.5
8. Comm. recreation				87.0		87.0	87.0		87.0
9. Residential				488.2		488.2	488.2		488.2
10. Livestock				716.0		716.0	716.0		716.0
11. Agriculture				69.9		69.9	69.9		69.9
12. Amenity	3,051.7		3,051.7				3,051.7		3,051.7
13. Fire services					48.5	48.5		48.5	48.5
14. Recreation		638.2	638.2		31.9	31.9		670.0	670.0
15. Mushrooms		442.9	442.9		17.9	17.9		460.8	460.8
16. Carbon		356.0	356.0					356.0	356.0
17. Landscape		438.1	438.1		2.3	2.3		440.4	440.4
18. Biodiversity		169.3	169.3		24.4	24.4		193.8	193.8
19. Water		1,443.2	1,443.2					1,443.2	1,443.2
Total	5,487.3	3,487.7	8,975.0	1,557.7	125.0	1,682.7	7,045.0	3,612.7	10,657.7

3.4.2 Intermediate product and own intermediate consumption

The valuation of the intermediate product at social price (IP_{sp}) has a large influence on the distribution of the values of its components of intermediate raw materials (IRM) and intermediate services (ISS). The IRM of the *dehesas* represent 15.8% of the IP_{sp} (Table S11).

Intermediate raw materials (IRM) are represented by woody products, grazing (livestock grazed fodder), successful hunts of inventoried migrant and settled species and harvested crop products intended for animal feed. Only intermediate game captures cannot be considered manufactured because they already have been valued for their environmental prices (Table S9-S10). For grazing (grass, browse, acorn and other wild fruits), although it is a manufactured intermediate raw material, its environmental price represents 95% of its manufactured stumpage price (Table S9-S10). We can conclude that the total value of IRM corresponds to grazing, as long as we consider that the value of intermediate game captures valued at environmental price is a substitute value for grazing consumed by these game species (Table S11).

Commercial intermediate services (ISSc) make up 19.8% of the values of intermediate services (ISS) while the remaining 80.2% is represented by non-commercial intermediate services (ISSnc) (Fig. 1, Table S11). The ISSc are provided by residential services, auto-consumed by farmers, in the amenity activity and those provided by government fire service

activity, consumed by public landscape conservation activity (Figs. 1-2). The ISSnc consist of 18.9% ordinary government compensation (ISSncc) and 81.1% auto-consumed (ISSnca) in amenity activity by farmers arising from voluntarily incurred opportunity costs (Fig. 1, Table S11).

The own intermediate consumption (ICo) is the accounting counterpart of the IP (Table S11). Own intermediate consumption of raw materials (RMo) is shared between hunting and livestock species (Table S11). Intermediate consumption of services (SSo) distribution is composed of 71.0% amenity activity, 28.6% landscape activity and 0.4% public recreational activity (Fig. 2, Table S11). As in the ISSnc, auto-consumed intermediate consumption of non-commercial services (SSncoa) accounted for 81.1% of SSnco (Fig. 2, Table S11).

The concern of part of the academic community for the null contribution of certain free goods and services to the transaction value of the final products consumed and, consequently, to the value of environmental assets in certain places and times is due to the invisibility of the biophysical contribution of nature to the net value added of economic activities in standard accounts. In other words, there is no consistent reason in advance for the determination of changes in property rights and natural resource policy that favor the change of a given good or service given by nature from "free" to "economic" and vice versa. Our interest in this article is not to discuss the general character and rationale by which commercial goods and services can be converted from "economic" to "free" or from "free" to "economic". Our interest is limited to interpreting the various contributions of several of the *dehesa* case studies' intermediate products, environmental work in progress used and final environmental products to the generation of various final products consumed that are owned by the farmer and the government.

We started the discussion of this issue with the government activity of fire services. This is based on the fact that the government considers the holm oak woodlands of the *dehesas* to be a public legacy that must be conserved for future generations, in a context where the landowner is not required to incur investment costs for their natural or artificial regeneration. In this circumstance the government fire service activity cost is not reflected in the intermediate consumption of grazing activity. This "free" service has the effect of reducing the cost of forage units grazed by the owner of the livestock. Thus, the value added of extensive livestock is higher than it would be if the same herd were kept grazing in the *dehesas*. A cost for the government fire service could not be attributed to the landowner grazing activity because we expected the government would maintain the same or even higher cost to maintain the value of the final landscape conservation services of the *dehesas* woodlands.

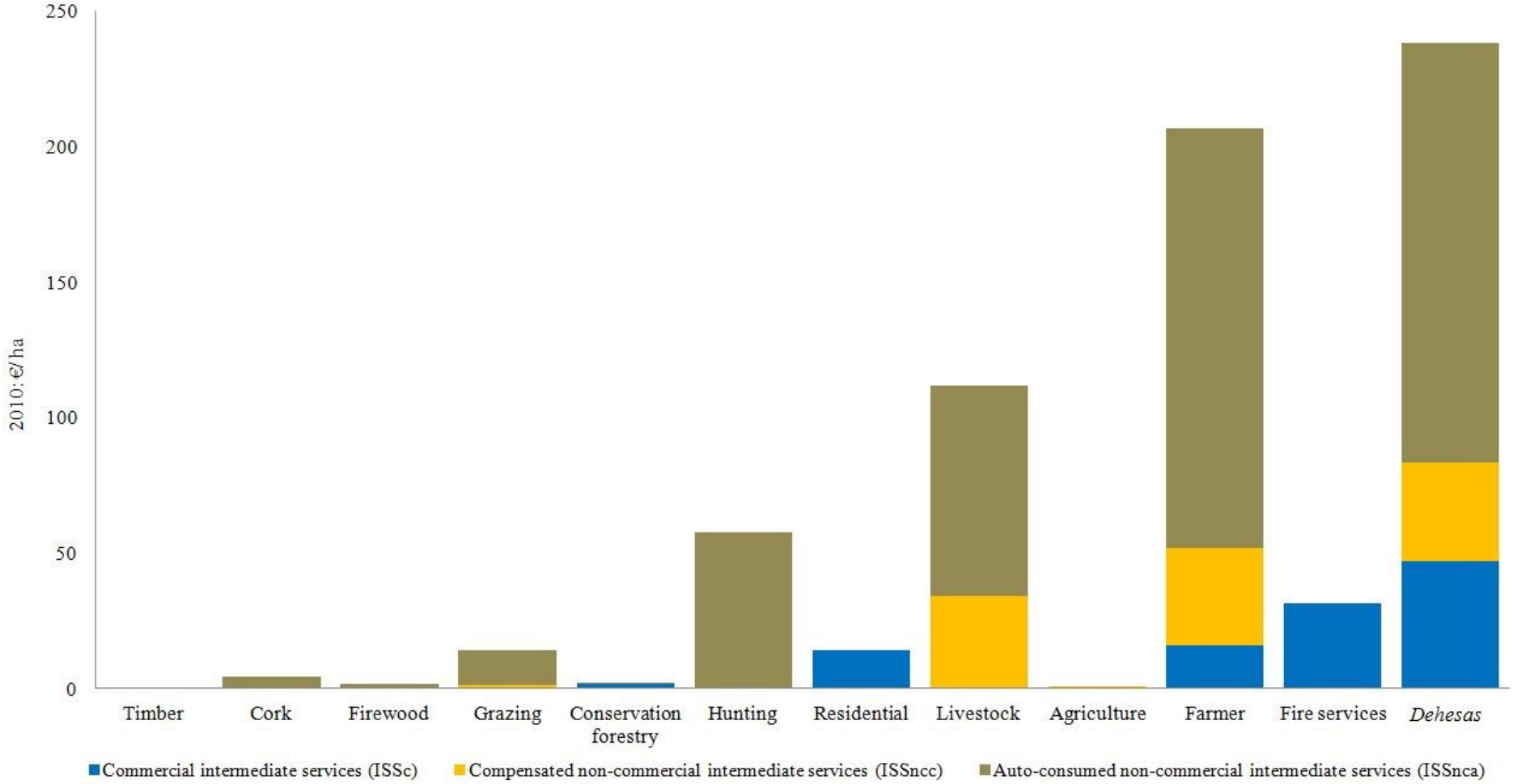

Figure 1. Holm oak *dehesa* case studies extended accounts intermediate services (2010: €/ha).

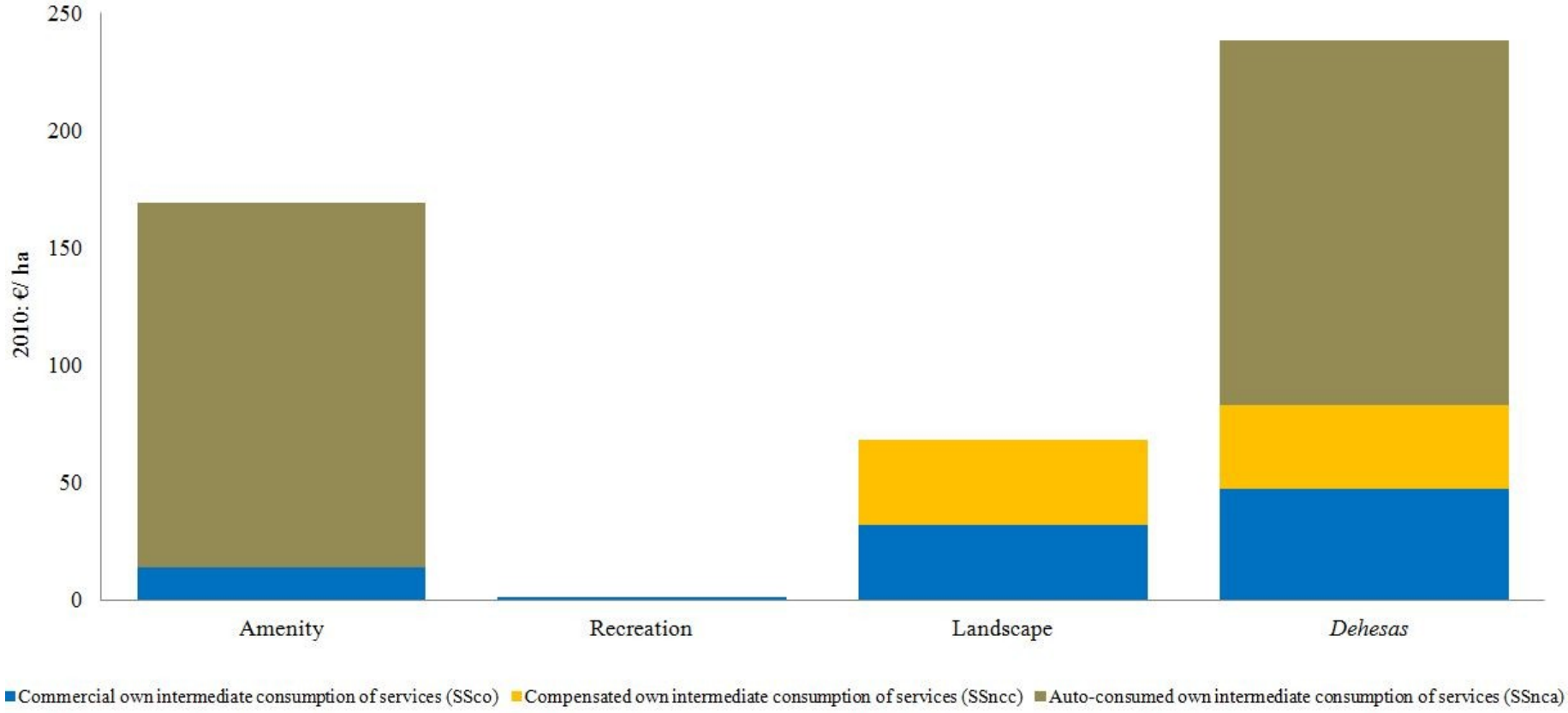

Figure 2. Holm oak *dehesa* case studies extended accounts intermediate consumption of services (2010: €/ha).

A free good that becomes an economic good due to the owner's right of exclusion from the use of the natural resource by third parties is the capture of migratory game species. These are recorded by their environmental price at the opening of the accounting period attached to the net present value from the captures of indefinite future periods in the land's environmental fixed asset and we have not recorded it as an environmental work in progress used (opposite we follow this last record criterion for the captures of the settled game species). The accounting consequence is that it is first recorded with the character of intermediate raw material valued at environmental price (in our case it is also the final product consumed market price). Thus, we know that in the *dehesas* the migratory hunting species can proceed in predominant numbers from breeding places of European and African countries. The condition being that the migratory hunting captures free goods contribute to a greater net value added of the *dehesas* and to increase the value of their game environmental fixed assets of the land.

Another outstanding circumstance is that of the "private" but in fact "free" goods collected by the recreational public in the *dehesas*. Among these, we noted the mushrooms harvested by the recreational public of free access to the *dehesas*. The legal status of mushrooms is one in which landowners have private ownership of any on their property. However, most owners do not prevent access to free mushroom collections by recreational visitors. The consequence is that the value of the environmental asset of mushrooms becomes public natural capital and its harvested product of mushrooms is equivalent to an ordinary environmental net margin of the government and from which benefits the public gatherers who usually consume it. In this example, the land owner is not affected by the net value added of the product of mushrooms, though it does affect that of the government, and therefore the total value added of the *dehesas*.

The conclusion that most motivates us to highlight the diversity of the free natural goods and services that affect the activities of the landowner and the government, is one that the extended net value added also makes visible the biophysical quantities used of free goods. Whether they are intermediate, environmental, a work in progress, used or final products, all favor the knowledge of the economic importance of the free natural resources embedded in the final products consumed of the *dehesas*. To us, that is the net value added which matters.

3.4.3 Net value added

In the *dehesas*, the conservation of the landscape is of social interest due to its value as a cultural legacy as well as for its ecosystem services, favored by the continuation of the commercial activities of the farmers and the government. Intermediate non-commercial

services that favour the demand for labor, thus fixing the population in the unpopulated rural areas where the *dehesas* are usually located, still represent additional economic values. For this reason, the employment generated by animal activities is the main cause for the maintaining of the quality of the public service of the cultural landscape of the holm oak *dehesas*. In the *dehesa* case studies, the labor demands generated by hunting and livestock activities contributed to 46.7% percent of employment demand, the fire service activity contributes 16.5%, and the remaining 15 activities only contributed to 37% of the employment demanded by the *dehesa* case studies. The labor cost of the *dehesas* contributed 52% of the net value added of commercial activities (262.9 €/ha) (excluding amenity, mushrooms, water and carbon activities) and the latter net value added contributed 51% of the total value added of the *dehesas* (Figs. 3-4, Tables S11-S12-S13-S14). It is concluded, from the estimates of the net values added of the *dehesas'* activities, that non-commercial intermediate services contributed to 37.1% of the total net value added and 59.9% of the net value added towards farmers at social prices (Figs. 3-4, Table S11).

The farmers' net value added at social price contributed to 62% of the total net added value of the *dehesa* case studies. This result highlights the economic character of the private-public mixed natural heritage of the *dehesas*, which are privately owned by the family farmers. In the extended accounts *dehesa* case studies, the net value added by the farmer was 1.6 times greater than those of the government (Figs. 3-4; Tables S11-S12-S13-S14). The environmental net operating margin (NOMe) shows great contrasts in its composition between farmers and the government in *dehesas* (Tables S11-S12-S13-S14).

3.4.4 Ecosystem services

Economic ecosystem services' extended accounts at social prices (ES_{sp}) make up 45.2 % of the value of the final products consumed in *dehesa* case studies (Figs. 5-6, Table S12). The ES provisioning, regulatory and cultural ecosystem services' account portions are, respectively, 43.3%, 18.1% and 38.5% (Table S15).

The farmer economic ecosystem services are 1.1 times higher than those of the government (Fig. 6, Tables S12-S13-S14). Cork, firewood, livestock grazing and hunting ecosystem services make up 34.1% of farmer ecosystem services. The private amenity ecosystem service represents 66% of a farmer's services (Fig. 6, Tables S12-S13-S14). Water and carbon contribute to, respectively, 46.3% and 28.0% of government ecosystem services. Farmer and government ecosystem services are 2.9 and 1.4 times higher than their respective environmental incomes (Fig. 6, Tables S13-S14).

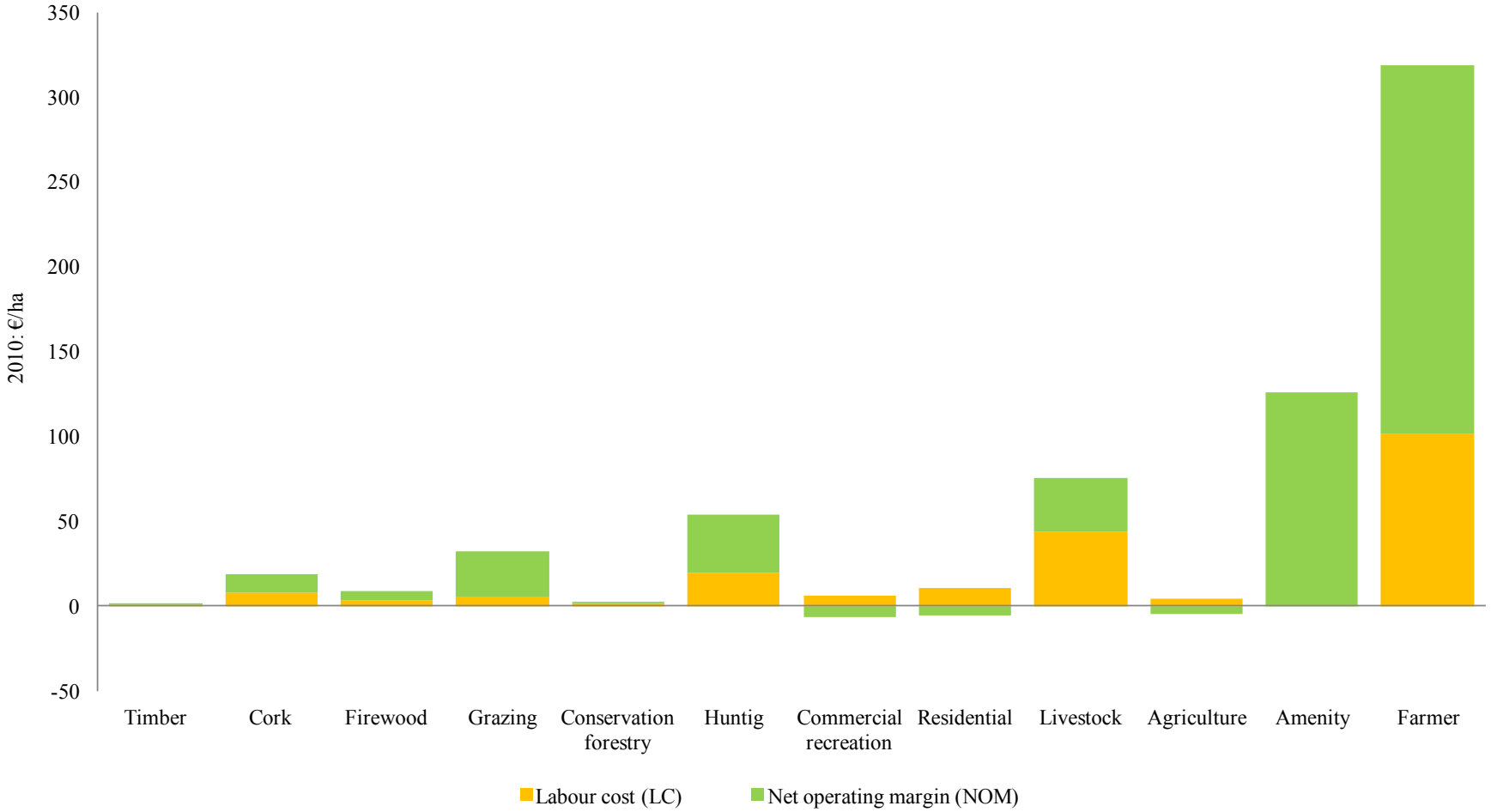

Figure 3. Holm oak *dehesa* case studies extended accounts farmer net valued added at social prices (2010: €/ha).

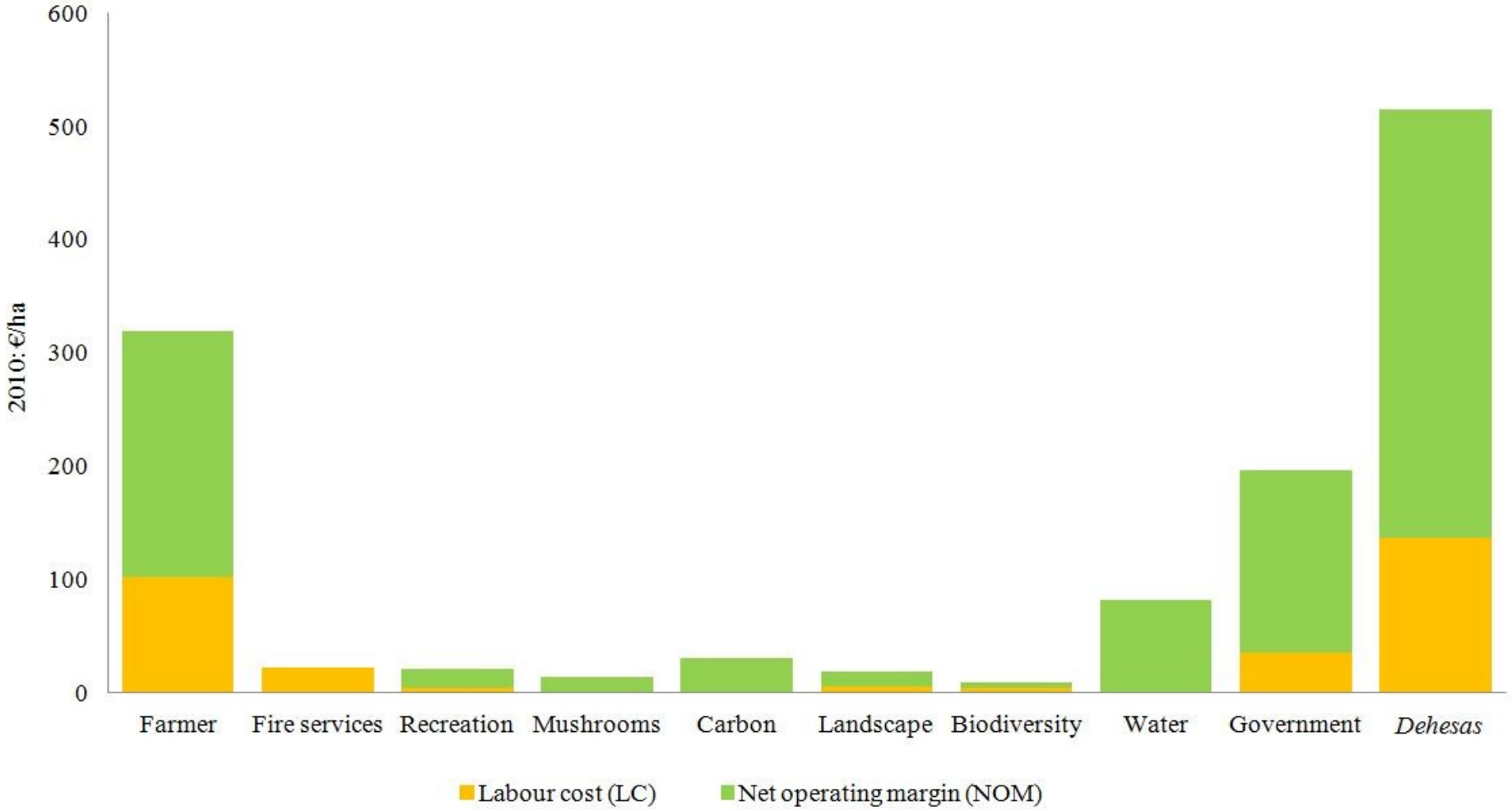

Figure 4. Holm oak *dehesa* case studies extended accounts farms net valued added at social prices (2010: €/ha).

3.4.5 Environmental income

The first total income (TI) result is depicted by the sum of the net value added at social price (NVA_{sp}) and the capital gain (CG) (Fig. S3). The NVA_{sp} is measured as the balancing item of the production account (Table S11). The CG is derived from the adjusted capital revaluation (Tables S7-S8). We reorganize this primary total income accounting identity in order to present the second TI accounting identity as the production factors of income returns. The individual production factor incomes are noted, respectively, as labour cost (LC), manufactured capital income (CIm) and environmental income (EI) (Figs. S3-S4). The EI of the *dehesas* is the main source of income, followed by the LC, while the CIm presents a negative result in 2010 due to the notable negative capital gain of manufactured immobilized capital (Figs. S3-S4). Once the environmental income has been estimated and embedded into the TI, our interest is then to reorganize the EI identity showed by Fig. S4 to obtain an identity that links the EI with the actual ecosystem services (ES_{sp}) and the adjusted change of environmental net worth (CNWead) at social prices (Figs. 5-6).

The environmental income of the holm oak *dehesa* case studies comes from the positive contribution of the ecosystem services and the negative adjusted change of the environmental net worth (Figs. 5-6, Tables S13-S14). This last item result is not due to an excess of physical consumption of resources over their natural growths in 2010, but stems mainly from the decrease in 2010 of the private amenity environmental asset price (Table S8). The carbon service also presents a notable negative flow of the change in its environmental net worth. Grazing and game activities show negligible negative changes in their environmental net worth (Figs. 5-6, Tables S13-S14).

The unsustainable 2010 economic ecosystem services outcome of *dehesa* case studies as a whole occurred at the same time than sustainable biophysical results were obtained (Table S3, Fig. S5). Although it is consistent to affirm the economic non-sustainability of the consumption of ecosystem services in 2010, due to its exceeding of the value of environmental income, the consistent meaning of the adjusted change in the environmental net worth of carbon and amenity referred to in the accounting period must be pointed out.

The variations of the future net flows of carbon from the holm oaks have a complete commercial life cycle exceeding two hundred years, and consequently the discount of the carbon resource rent at a rate of 3%, demonstrates that the flows far away from the present do not influence the valuation of the environmental asset revaluation of the carbon from the holm oaks. On the contrary, the current cycles of the aging holm oaks give higher weight to the greater emissions that are produced in periods closer to the current one. Contrarily, carbon net fluxes have a cutting cycle of circa 25 years on average. This shorter rotation harvest turn has significant influence on the carbon environmental income result (Fig. 6, Tables S13-S14).

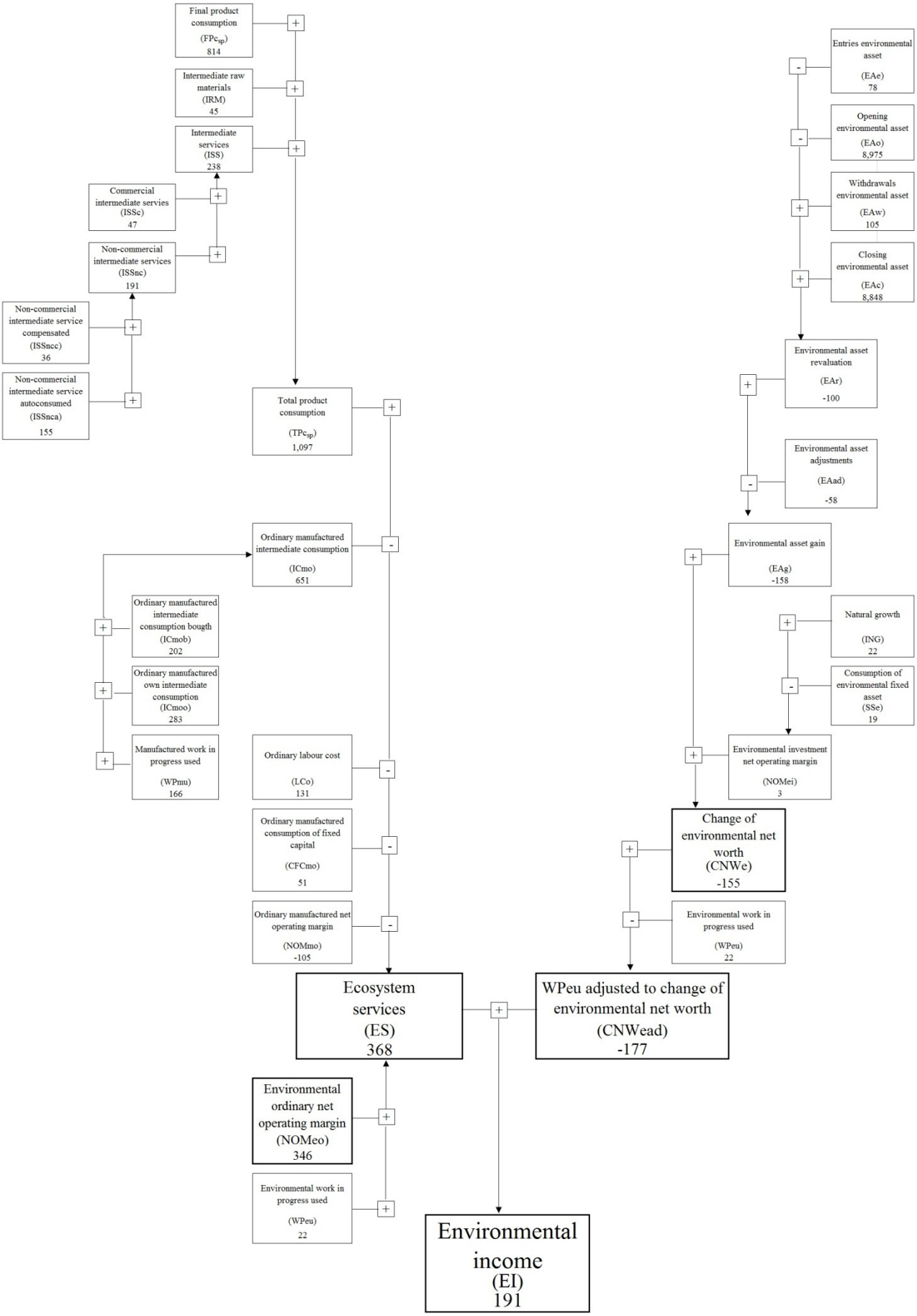

Figure 5. Holm oak *dehesa* case studies extended accounts farms environmental income at social prices (2010: €/ha).

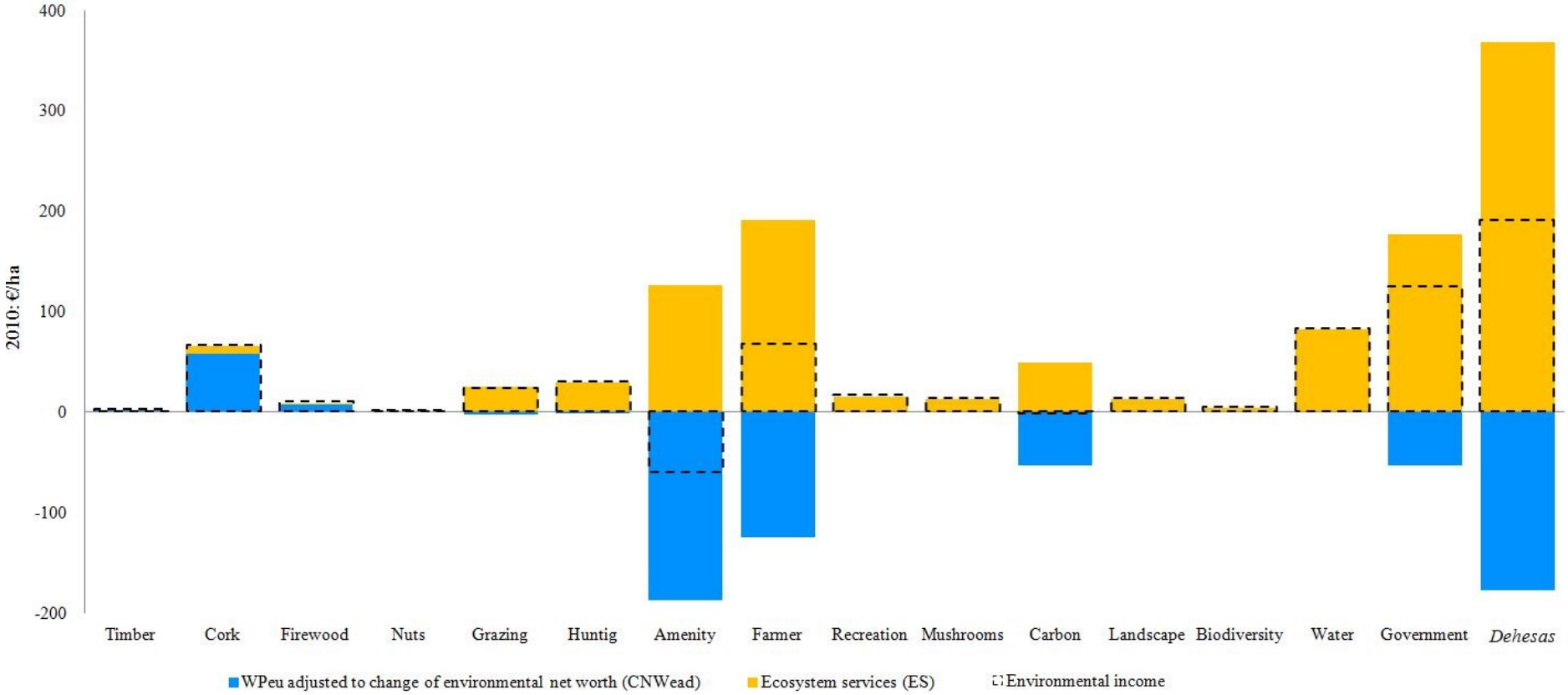

Figure 6. Holm oak dehesa case studies extended accounts economic activities ecosystem services and adjusted change of environmental net worth at social prices (2010: €/ha).

Amenities may be affected by high year-to-year variations in land prices of opposite signs (Fig. 6). We have estimated that in the Spanish *dehesas* in the period 1994-2010 they reflect upon positive land real prices a cumulative rate change (Ovando et al., 2016; Oviedo et al., 2017).

The implication of the *dehesa* case studies economic environmental income results analysis is one that could bring about revaluations of carbon and amenity environmental assets in the long-term that we have not looked past in the closing environmental assets valuations in 2010, all things being equals.

In the *dehesas*, the environmental income represents 67% of the total income (Figs. S3-S4; Tables S13-S14). The government manages activities which produce 1.9 times more environmental income than those of the farmer (Figs. 5-6, Tables S13-S14). The environmental income of the famer differs considerably from those of the government mainly as a result of the land depreciation and the economic water runoff stored in the watershed public dams during the accounting period.

The main positive environmental incomes from the farmer's individual activities come from cork, grazing and hunting. Private amenities cause a negative environmental income in the current period (Fig. 6, Table S13-S14). In individual government activities, water generates a notable positive environmental income, while carbon contributes a slightly negative environmental income (Fig. 6, Table S13-S14).

3.4.6 Social prices versus producer and basic prices effects on ecosystem services and incomes

At the farm level, comparative measurements of ecosystem services at producer and basic prices are 1.8 times higher than ecosystem services valued at their social price (Tables 3-S16-S17). The same comparisons of farms regarding environmental incomes offer estimates at producer and basic prices 1.5 and 1.4 times higher than those estimated at social prices (Tables S16).

There are notable differences between individual *dehesas* in terms of the quantity and composition of their respective incomes and ecosystem services at social prices. Although our sample of *dehesas* does not intend to be representative of the population, the statistics shown in Table S18 provides an idea of the dispersion of the different estimations. Net value added shows the closest proximity between mean and median and the lower coefficient of variation, implying that this indicator shows the most stable values in the sample. The largest difference between mean and median is found for surface areas due to the presence of three extreme values in the upper tail of the distribution.

Table 3. Holm oak *dehesa* case studies extended and refined standard accounts farmer ecosystems services and gross value added indices comparisons (2010).

Class	Timber	Cork	Firewood	Nuts	Grazing	Conserv. forestry	Hunting	Comm. recreation	Residential	Livestock	Agriculture	Amenity	Farmer
	1	2	3	4	5	6	7	8	9	10	11	12	13=∑1-12
Ecosystem services													
$ES_{pp,E}/ES_{sp,E}$	0.0	1.0	1.0	0.0	1.0		1.0					2.2	1.8
$ES_{bp,E}/ES_{sp,E}$	0.0	1.0	1.0	0.0	1.0		1.0					2.2	1.8
$ES_{bp,Sr}/ES_{sp,E}$	0.0	1.0	1.0	0.0	1.0		1.0						0.3
$ES_{pp,Sr}/ES_{pb,Sr}$	0.0	1.0	1.0	0.0	1.0		1.0						1.0
Gross value added													
$GVA_{pp,E}/GVA_{sp}$	0.2	0.8	0.8	0.0	0.6	0.7	0.1	1.0	1.0	-0.2	0.5	2.2	0.9
$GVA_{bp,E}/GVA_{sp,E}$	0.2	0.8	0.8	0.0	0.6	0.7	0.1	1.0	1.0	0.1	1.0	2.2	1.0
$GVA_{bp,Sr}/GVA_{sp,E}$	0.2	0.8	0.8	0.0	0.6	0.7	0.1	1.0	1.0	0.0	0.8		0.2
$GVA_{pp,Sr}/GVA_{bp,Sr}$	1.0	1.0	1.0	0.0	0.9	1.0	1.0	1.0	1.0	8.7	0.4		0.5

Abbreviations: The subscript pp is producer prices, the subscript bp is basic prices, the subscript sp is social prices, the subscript E is the extended accounts and the subscript Sr is the revised standard accounts.

However, the coefficient of variation for this variable is not as high as for capital income and environmental income. For ecosystem services, while showing a wide range of values, the median and mean are very close and the coefficient of variation is also low compared to the other indicators, excluding the aforementioned net value added. In summary, it seems that the indicators that incorporate some form of capital gain show higher variability of values.

3.5 Accounting frameworks economic results comparison

Farmer standard and extended accounts total capital equate and government's manufactured capital also equate. The total opening capital of the extended accounts is 18% greater than that of the standard accounts (Tables 2-S7-S8). Extended accounts environmental assets are 22% higher than that of the standard accounts (Tables 2-S7-S8). The government's environmental assets estimated by the extended accounts are 85% higher than those measured by the standard accounts. These differences are due to the fact that the standard accounts value at production cost the private amenity auto-consumption, and the public products of recreation, landscape, biodiversity, as well as the water supply, though only partially.(Tables 2- S7-S8).

The reduced contributions of the harvested woody products and their natural growths motivate the practical absence of the bias of the temporization in the measurement of the standard accounts of the woody products for the case of the holm oak farms case studies.
Extended accounts farmer intermediate product is 2.6 times of their respective standard accounts (Table S5-S6- S11).

The total cost of extended accounts is 1.7 times higher than the corresponding cost of refined standard accounts (Tables S5-S6-S11). This variation is due to the incorporation of the intermediate consumption of amenities and the environmental product in progress used.

The extended and refined standard accounts results for intermediate amenity services reveal that *dehesa* case studies' livestock and hunting activities managements are orientated towards private landowner amenity auto-consumption.

The refined standard accounts applied to the *dehesa* case studies show measurements at basic prices of the ecosystem services and gross value added that are, respectively, 0.4 and 0.3 times of those of the respective values offered by the extended accounts at social prices (Tables 3-4-S16-S17, Fig. 7).

The comparative environmental incomes of the *dehesa* case studies (Fig. 8) show values of the accounts extended at social prices and of the standard accounts refined at basic

prices, respectively, of 190.8 €/ha and 22.6 €/ha (Tables S5-S6-S16-S17). The same comparison referring to the farmer offers the values of environmental income of the respective accounts of 66.5 €/ha and -59.6 €/ha (Tables S5-S6-S16-S17).

4. Policy matters and concluding remarks

4.1 Policy matters

The fact that economic ecosystem service is limited to the value of its contribution to the product consumed leads to the exclusion of its natural growth in valuing the former as a spatial unit, because its condition as environmental gross capital formation does not contribute to human wellbeing in the accounting period. The SEEA-EEA admits this ecosystem service concept limitation, which is related to the lack of direct link with the product consumption sustainability. The SEEA-EEA recommended to adjust the gross value added by the excess of the natural resource extraction over the natural growth for the accounting period. Nevertheless, to estimate the latter, adjusted gross value added is not sufficient, since this adjustment does not take into account the revaluation of the environmental assets where natural growth of the resource exceeds their extraction in the accounting period.

This research advocates that the environmental income is a variable which expresses potential sustainable economic natural resource extraction, as long as no individual environmental asset is on the verge of extinction. Where this condition is fulfilled, meaning that a critical threshold of environmental assets does not apply, the environmental income represents a maximum potential ecosystem service contribution to sustainable product consumption in the spatial unit.

In this extended accounts application to the *dehesas* the ecosystem services value is higher than the environmental income, therefore the period's environmental income is not sustainable. However, even the environmental income being higher than the ecosystem service the former may not reflect sustainable physical ecosystem service consumption. This potential discrepancy between the economic and physical sustainability of environmental income is due to the fact that the period's environmental income represents a social relationship of reciprocal exchange while the second one represents a biotic functional relationship external to human numeracies.

Table 4. Holm oak d*ehesa* case studies extended and refined standard accounts farms ecosystems services and gross value added indices comparisons (2010).

Class	Farmer 13	Fire services 14	Recreation 15	Mushrooms 16	Carbon 17	Landscape 18	Biodiversity 19	Water 20	Government 21=∑14-20	*Dehesas* 22=13+21
Ecosystem services										
$ES_{pp,E}/ES_{sp,E}$	1.8		1.0	1.0	1.0	3.8	1.0	1.0	1.2	1.5
$ES_{bp,E}/ES_{sp,E}$	1.8		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.4
$ES_{bp,Sr}/ES_{sp,E}$	0.3		0.0	1.0	0.0	0.0	0.0	0.9	0.5	0.4
$ES_{pp,Sr}/ES_{pb,Sr}$	1.0		0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0
Gross value added										
$GVA_{pp,E}/GVA_{sp}$	0.9	1.0	1.0	1.0	1.0	2.7	1.0	1.0	1.2	1.0
$GVA_{bp,E}/GVA_{sp,E}$	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
$GVA_{bp,Sr}/GVA_{sp,E}$	0.2	1.0	0.2	1.0	0.0	0.4	0.4	0.9	0.6	0.3
$GVA_{pp,Sr}/GVA_{bp,Sr}$	0.5	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.8

Abbreviations: The subscript pp is producer prices, the subscript bp is basic prices, the subscript sp is social prices, the subscript E is the extended accounts and the subscript Sr is the revised standard accounts.

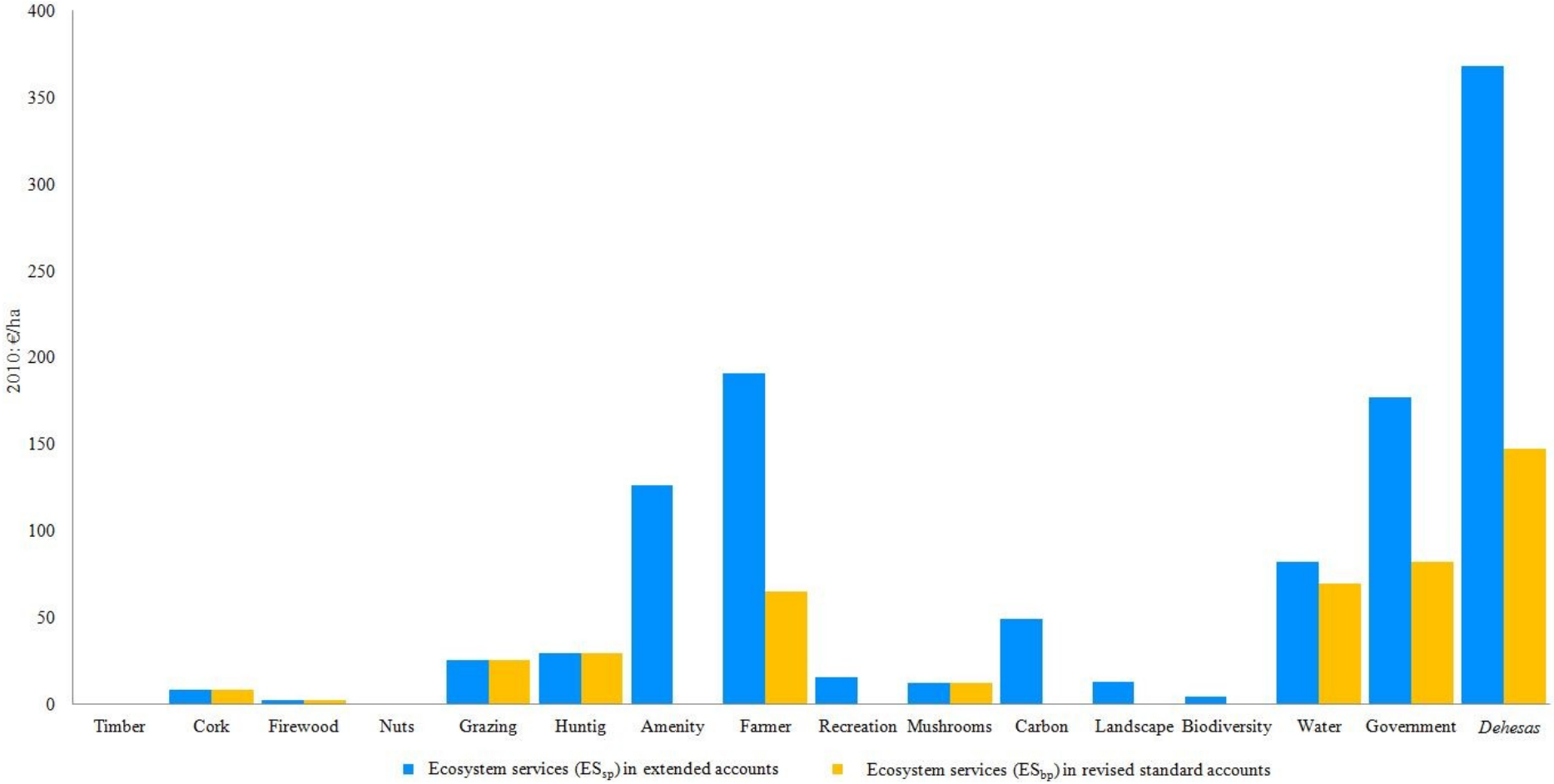

Figure 7. Holm oak *dehesa* case studies extended and refined standard accounts comparisons of ecosystem services at social and basic prices (2010: €/ha).

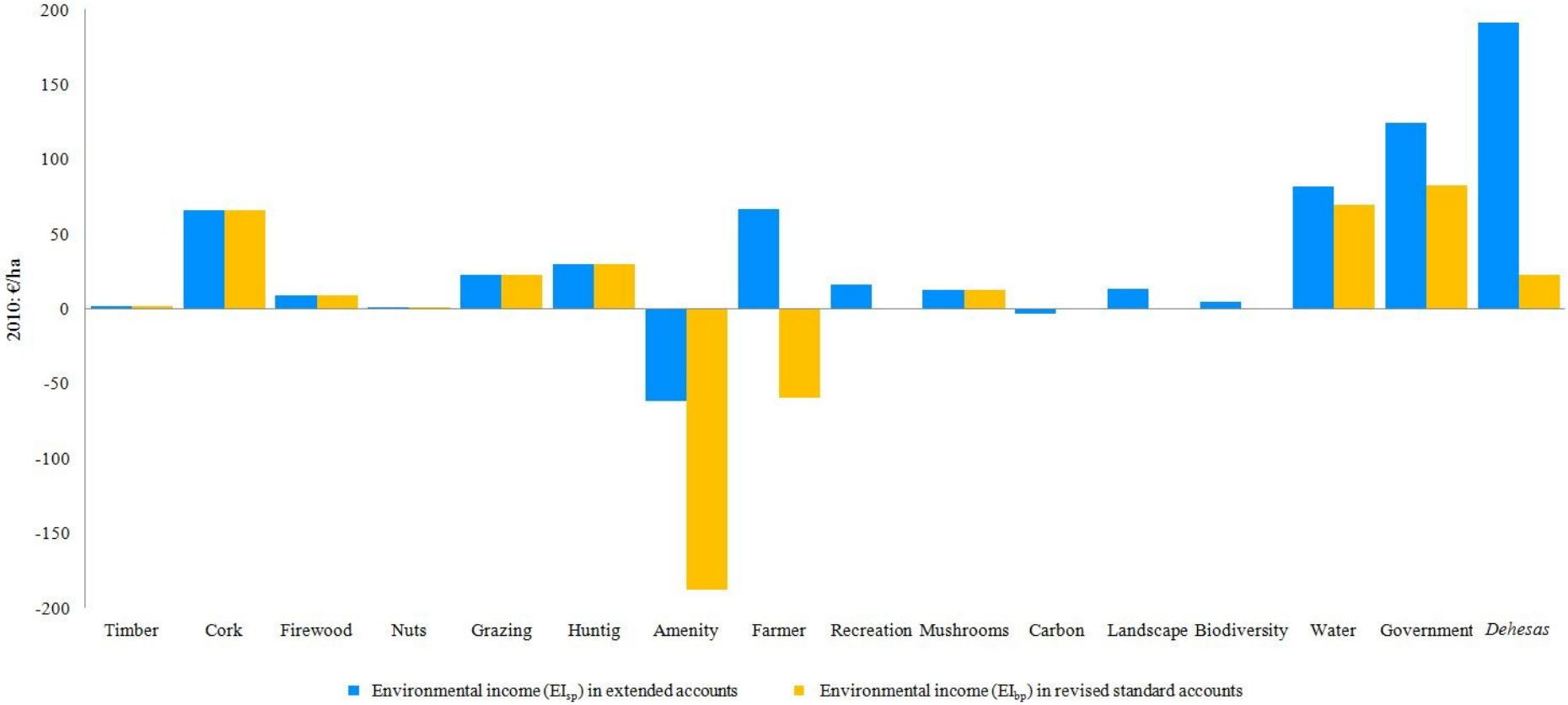

Figure 8. Holm oak *dehesa* case studies extended and refined standard accounts comparisons of environmental income at social and basic prices (2010: €/ha).

The economic valuation of renewable natural resources presents an insurmountable weakness in situations where critical thresholds of environmental asset preservation exist. This weakness is well documented in economic science and the only way to deal with it is by exercising precaution. When it is known that the future regeneration capacity of a given environmental asset is in danger of extinction due to its extreme physical scarcity, then the loss of well-being for current generations associated with the preservation of this environmental asset may be imposed by the government on consumers, as long as current generations consider the cost inherent cost as tolerable. In this *dehesas* research, the threatened biodiversity activity was guaranteed of their preservations by the consumers' willingness-to-pay, thereby facilitating conservationist *dehesa* management by the government.

There are also policy matters on the measurement of gross value added in situations where ecosystem services have zero economic values. Physical natural products harvested usually are valuable data that inform of their free contributions to maintain economic activities in the spatial unit. Thus, free physical ecosystem services could make possible to satisfy the basic needs of the poorest rural families in many areas of the world (Sjaastad et al., 2005).

4.2 Concluding remarks

It should be noted that the measurement of gross value added is a result obtained from the effects of actions taken by the owner and the government in the past. The relevant question here is whether these actions would have been the same if the owners had known earlier that the compensation and opportunity costs would be different. In other words, voluntary compensation and opportunity costs condition management options preferred by landowners in the future and consequently the gross added values of the *dehesas* could vary without having been anticipated in the valuation of the environmental assets at the closing of the accounting period.

The ecosystem services only take into consideration the consumption of products with positive residual result estimates. The natural growth during the accounting period stored at the end of the period in the spatial unit is not included in the current ecosystem service estimate as it did not contribute to the wellbeing of the consumers during the accounting period. In addition, double accounting of ecosystem services is avoided in the period in which the accumulated growth from previous periods will be harvested. Thus, the definition of ecosystem services does not coincide with that of the environmental net operating margin. To overcome this shortcoming of the concept of ecosystem services, i.e. its failure to inform

economic contribution to current total income in a spatial unit, this research advocates measuring environmental income.

These *dehesas* results confirm the consistency of the extended accounts estimates based on extended accounts total product and total income of individual *dehesa* activities, which some are linked by the production of intermediate services and consumption of own services across many of them. The results reveal that the productive functions of intermediate services link multiple activities under farmer and the government responsibilities. These interactions take place simultaneously inside the *dehesa's* economic activities and they are the guide that oriented the extended and refined accounts applications. We recognize that it is an almost impossible task to measure ecosystem services and environmental incomes from the individual economic activities of agroforestry farms managed by the farmer and the government. The difficulties are amplified by the need to have information on government expenditures attributed to farm activities as well as a designing of bio-economic models scheduled for the future that guarantee the economic and ecological sustainability of farm environmental assets indefinitely. Nevertheless, this *dehesas* research showed it is possible to measure consistent physical and economic indicators, while providing information on environmental and manufactured values on ecosystem services, environmental incomes, total income, change of net worth, environmental assets and total capital. The comparison of the extended and refined standard accounts ecosystem services shows great variations motivated by the refined standard accounts omissions and biases of the products and costs valuations in agroforestry farms.

The *dehesas* results show that the refined standard accounts data shortcomings can be overcome by building and applying extended accounts to better inform government policy design and landowner scheduled sustainable managements of the natural resources use.

Such extended accounts could inform policy makers how to better mitigate failures through the design and implementation of government policies and landowner-scheduled sustainable managements of the natural resources, with any agroforestry micro spatial economic unit.

Acknowledgments

The authors thank the Agency for Water and Environment of the Regional Government of Andalusia for the financial and field work support for the *REnta y CApital de los Montesd de ANdalucía* (RECAMAN) project (Contract NET 165602), the *Valoraciones de servicios y activos de AMenidades privadas de fincas SILvopastorales* (VAMSIL) project of CSIC (ref.: 201810E036) and the Mapping and Assessment for Integrated ecosystem Accounting (MAIA) project of EU call H2020-SC5-2018-1 (Grant Agreement Nr. 817527). We acknowledge the contributions of Eloy Almazán and Begoña Álvarez-Farizo and other colleagues in the framework of the RECAMAN project to the methods and results presented in this article. We thank Daniel Jordan for helping us to review the English writing and the two reviewers for suggesting substantial improvements of the original version of this research.

References

Atkinson, G., Obst, C., 2017. Prices for ecosystem accounting. WAVES. https://www.wavespartnership.org/sites/waves/files/kc/Prices%20for%20ecosystem%20accounting.pdf (accessed 2 October 2018)

BOJA (Boletín Oficial de la Junta de Andalucía), 2010. Ley 7/2010, de 14 de julio, para la Farm. Boletín Oficial de la Junta de Andalucía, 144, Seville, 120 pp.

Campos, P., Daly, H., Oviedo, J.L., Ovando, P., Chebil, A., 2008. Accounting for single and aggregated forest incomes: Application to public cork oak forests of Jerez in Spain and Iteimia in Tunisia. Ecol. Econ 65, 76-86. doi: 10.1016/j.ecolecon.2007.06.001

Campos, P., Huntsinger, L., Oviedo, J.L., Starrs, P. F., Díaz, M., Standiford, R.B., Montero, G. 2013. Mediterranean Oak Woodland Working Landscapes. Dehesas of Spain and Ranchlands of California. Springer, Dordrecht, Heidelberg, New York, London, 508 pp.

Campos, P., Ovando, P., Mesa, B., Oviedo, J.L., 2016. Environmental income of grazing on privately-owned silvopastoral farms in Andalusia. J. Land. Degrad. Dev. Special issue. doi:10.1002/ldr.2529

Campos, P., Mesa, B., Álvarez, A., Castaño, F.M., Pulido, F., 2017. Testing extended accounts in scheduled conservation of open woodlands with permanent livestock grazing: Dehesa de la Luz Estate case study, Arroyo de la Luz, Spain. Environments 4 (4), 82, 1–38. doi:10.3390/environments4040082.

Campos, P., Caparrós, A., Oviedo, J.L., Ovando, P., Álvarez-Farizo1, B., Díaz-Balteiro, L., Carranza, J., Beguería, S., Díaz, M., Herruzo, A.C., Martínez-Peña, F., Soliño, M., Álvarez, A., Martínez-Jáuregui, M., Pasalodos-Tato, M., de Frutos, P., Aldea, J., Almazán, E., Concepción, E.D., Mesa, B., Romero, C., Serrano-Notivoli, R., Fernández, C., Torres-Porras, J., Montero, G., 2019. Bridging the gap between national and ecosystem accounting application in Andalusian forests, Spain. Ecol. Econ. 157, 218–236. doi.org/10.1016/j.ecolecon.2018.11.017

Caparrós, A., Oviedo, J.L., Álvarez, A., Campos, P., 2017. Simulated exchange values and ecosystem accounting: Theory and application to recreation. Ecol. Econ. 139, 140–149. doi: 10.1016/j.ecolecon.2017.04.011

Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S., Grasso, M., 2017. Twenty years of ecosystem services: How far have we come and how far do we still need to go? Ecosyst. Serv. 28, 1-16. doi: 10.1016/j.ecoser.2017.09.008

Edens, B., Hein, L., 2013. Towards a consistent approach for ecosystem accounting. Ecol. Econ. 90, 41–52. doi: 10.1016/j.ecolecon.2013.03.003

EFTEC (Economics for the Environment Consultancy Ltd), 2015. Developing UK natural capital accounts: woodland ecosystem accounts. Department for Environment, Food and Rural Affairs (Defra). London, 97 pp.
http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=18909 (accessed on 14 September 2017)

Eigenraam, M., Obst, C., 2018. Extending the production boundary of the System of National Accounts (SNA) to classify and account for ecosystem services, Ecosyst. Health Sustainability 4(11), 247–260. doi: 10.1080/20964129.2018.1524718

European Commission, International Monetary Fund, Organization for Economic Co-operation and Development, United Nations, World Bank, 2009. System of National Accounts 2008 (SNA 2008). New York, 722 pp. http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf (accessed on 27 September 2017)

European Commission, 2011. Our life insurance, our natural capital: an EU biodiversity strategy to 2020. COM(2011) 244 final. Brussels, 17 pp. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0244&from=EN (accessed on 23 January 2018)

European Commission, 2016. Report on phase 1 of the knowledge innovation project on an integrated system of natural capital and ecosystem services accounting in the EU (KIP-INCA Phase 1 report). http://ec.europa.eu/environment/nature/capital_ accounting/pdf/KIP_INCA_final_report_phase-1.pdf (accessed on 14 September 2017)

European Communities, 2000. Manual on the Economic Accounts for Agriculture and Forestry EEA/EAF 97 (Rev. 1.1). EC, EUROSTAT, Luxembourg, 172 pp. http://ec.europa.eu/eurostat/documents/3859598/5854389/KS-27-00-782-EN.PDF/e79eb663-b744-46c1-b41e-0902be421beb (accessed on 14 September 2017)

European Union, 2011. Regulation (EU) No 691/2011 on European environmental economic accounts. Official Journal of the European Union 192. p. 1. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:192:0001:0016:EN:PDF (accessed on 27 September 2017)

FAO (Food and Agriculture Organization of the United Nations), 2017. System of Environmental-Economic Accounting for agriculture, forestry and fisheries. Statistics. 138 pp. http://www.fao.org/economic/ess/environment/methodology/en/ (accessed on 14 May 2019)

Haines-Young, R., Potschin, M., 2013. CICES V4.3 – Refined report prepared following consultation on CICES Version 4. http://unstats.un.org/unsd/envaccounting/seearev/GCComments/CICES_Report.pdf (accessed on 27 September 2017)

Keith, H., Vardon, M., Stein, J.A. Stein, J.L., Lindenmayer, D., 2017. Ecosystem Accounts define explicit and spatial trade-offs for manging natural resources. Nat. Ecol. Evol. 1(11), 1683–1692. doi: 10.1038/s41559-017-0309-1

La Notte, A., Vallecillo, S., Polce, C., Zulian, G., Maes, J., 2017. Implementing an EU system of accounting for ecosystems and their services. Initial proposals for the implementation of ecosystem services accounts, EUR 28681. Publications Office of the European Union, Luxembourg, pp. 1–124. doi:10.2760/214137, JRC107150

La Notte, A., Vallecillo, S., Marques, A., Maes, J., 2019a. Beyond the economic boundaries to account for ecosystem services. Ecosyst. Serv. 35, 116–129. doi: 10.1016/j.ecoser.2018.12.007

La Notte, A., Vallecillo, S., Maes, J., 2019b. Capacity as "virtual stock" in ecosystem services accounting. Ecol. Indic. 98, 158-163. doi: 10.1016/j.ecolind.2018.10.066

Martín, M., Espejo, M., Plaza, J., López, T., 1987. Cálculo de la carga ganadera en la dehesa. In: Campos P., Martín M (Coord.), Conservación y desarrollo de las dehesas portuguesa y española. Secretaría General Técnica, Ministerio de Agricultura, Pesca y Alimentación: Madrid, pp. 239-258.

McElroy, M.B., 1976. Capital gains and social income. Econ. Inquiry XIV, 221–240.

Maes, J., Liquete, C., Teller, A., Erhard, M., Paracchini, M.L., Barredo, J.I., Grizzetti, B., Cardoso, A., Sommaa, F., Peterse, J.E., Meiner, A., Royo-Gelabert, E., Zal, N., Kristensen, P., Bastrup-Birk, A., Biala, K., Piroddi, C., Egoh, B., Degeorges, P., Fiorina, C., Santos-Martín, F., Naruševičius, V., Verboven, J., Pereira, H.M., Bengtsson, J., Gocheva, K., Marta-Pedroso, C., Snäll, T., Estreguil, C., San-Miguel-Ayanz, J., Pérez-Sobam, M., Grêt-Regamey, A., Lillebø, A.I., Malak, D.A., Condé, S., Moen, J., Czúcz, B., Drakou, E.G., Zulian, G., Lavalle, C., 2016. An indicator framework for assessing ecosystem services in support of the EU Biodiversity Strategy to 2020. Ecosyst. Serv. 17, 14–23. doi: 10.1016/j.ecoser.2015.10.023

Maler, K., Aniyar, S., Jansson, Å., 2008. Accounting for ecosystem services as a way to understand the requirements for sustainable development. PNAS 105(28), 9.501–9.506. doi: 10.1073/pnas.0708856105

Masiero, M., Pettenella, D., Boscolo, M., Barua, S.K, Animon, I., Matta, J.R., 2019. Valuing forest ecosystem services: a training manual for planners and project developers. Forestry Working Paper 11. FAO, Rome, 216 pp. Licence: CC BY-NC-SA 3.0 IGO.

MAPA (Ministerio de Agricultura, Pesca y Alimentación), 2008. Diagnóstico de las Dehesas Ibéricas Mediterráneas; MAPA. Secretaría General de Agricultura y Alimentación. Dirección General de Desarrollo Rural, Tomo 1, Madrid.

MAPA (Ministerio de Agricultura, Pesca y Alimentación), 2010. Red contable agraria nacional (metodología) España. Secretaría General Técnica. https://www.mapa.gob.es/es/estadistica/temas/estadisticas-agrarias/economia/red-contable-recan/ (accessed on 14 May 2019)

Obst, C., Hein, L., Edens, B., 2016. National Accounting and the Valuation of Ecosystem, Assets and Their Services. Environ. Resour. Econ. 64, 1–23. doi: 10.1007/s10640-015-9921-1
ONS (Office for National Statistics), Defra (Department for Environment, Food and Rural Affairs), 2017. Principles of Natural Capital Accounting. Office for National Statistics , 52 pp. https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/principlesofnaturalcapitalaccounting (accessed on 14 September 2017)

Ogilvy, S., Burritt, R., Walsh, D. Obst, C., Meadows, P., Muradzikwa, P., Eigenraam, M., 2018. Accounting for liabilities related to ecosystem degradation, Ecosyst. Health Sustainability 4(11), 261-276. doi: 10.1080/20964129.2018.1544837

Ovando, P., Campos, P., Oviedo, J.L., Caparrós, A., 2016. Ecosystem accounting for measuring total income in private and public agroforestry farms. For. Policy Econ. 71, 43–51. doi: 10.1016/j.forpol.2016.06.031

Oviedo, J.L., Huntsinger, L., Campos, P., 2017. Contribution of amenities to landowner income: Case of Spanish and Californian hardwood. Rangeland Ecol. Manage. 70, 518–528. doi: 10.1016/j.rama.2017.02.002

Raunikar, R., Buongiorno, J., 2006. Willingness to pay for forest amenities: The case of non-industrial owners in the south central Unite States. Ecol. Econ. 56, 132–143. doi:10.1016/j.ecolecon.2005.01.013

Remme, R.P., Edens, B., Schröter, M., Hein, L., 2015. Monetary accounting of ecosystem services: a test case for Limburg Province, the Netherlands. Ecol. Econ. 112, 116–128 . doi:10.1016/j.ecolecon.2015.02.015

Sjaastad, E., Angelsen, A., Vedeld, P., Bojö, J., 2005. What is environmental income? Ecol. Econ. 55, 37– 46. doi:10.1016/j.ecolecon.2005.05.006

Sumarga, E., Hein, L., Edens, B., Suwarno, A., 2015. Mapping monetary values of ecosystem services in support of developing ecosystem accounts. Ecosyst. Serv. 12, 71–83. doi:10.1016/j.ecoser.2015.02.009

United Nations, 2012. The Future We Want: Outcome Document Adopted at Rio + 20. United Nations, Rio de Janeiro, 49 pp. http://www.un.org/disabilities/documents/rio20_outcome_document_complete.pdf (accesed 23 January 2018).

United Nations, European Union, Food and Agriculture Organization of the United Nations, International Monetary Fund, Organization for Economic Cooperation and Development, World Bank, 2014a. System of Environmental– Economic Accounting 2012 –Central Framework [SEEA-CF].United Nations, New York, 378 pp. https://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf (accessed on 14 September 2017).

United Nations, European Commission, Food and Agriculture Organization of the United Nations, Organization for Economic Co-operation and Development, World Bank Group, 2014b. System of Environmental Economic Accounting 2012— Experimental Ecosystem Accounting. United Nations, New York, 198 pp. http://ec.europa.eu/eurostat/documents/3859598/6925551/KS-05-14-103-EN-N.pdf (accessed on 14 September 2017).

United Nations, 2017. Technical Recommendations in support of the System of Environmental-Economic Accounting 2012–Experimental Ecosystem Accounting, pp. i-xiii + 1–180. https://seea.un.org/sites/seea.un.org/files/technical_recommendations_in_support_of_the_seea_eea_final_white_cover.pdf (accessed 17 December 2018)

World Bank, 2016. Wealth Accounting and Valuation of Ecosystem Services (WAVES). Annual Report. https://www.wavespartnership.org/sites/waves/files/kc/WAVES%20Annual%20Report%202016_6.6.16.pdf (World Bank, 2016).

Appendix: Supplementary material

Uncovering the hidden ecosystem services embedded in environmental incomes: Testing experimental extended accounts in *dehesas* of holm oak woodlands, Andalusia-Spain

Pablo Campos, Alejandro Álvarez, Bruno Mesa, José L. Oviedo, Paola Ovando, Alejandro Caparós

*Corresponding author: pablo.campos@csic.es.

This Appendix file includes:

Supplementary text for

Uncovering the hidden ecosystem services embedded in environmental incomes: Testing experimental extended accounts in *dehesas* of holm oak woodlands, Andalusia-Spain

List of contents:

S1. Holm oks *dehesas* case studies revised standard accounts

Self-employed labor cost (LCse) is used in the *dehesa* farms case studies. For this reason the standard accounts net valued added at basic price ($NVA_{bp,S}$) incorporates the standard net mixed income ($NMI_{bp,S}$). We separate standard $NMI_{bp,F,S}$ into the cost of self-employed labor (LCse) and the net operating margin ($NOM_{MI,bp,S}$). Thus, we refine the standard SNA accounts labor cost (LCr) and the net operating surplus ($NOSr_{bp,S}$):

$$GVA_{bp,S} = TP_{bp,S} - IC_S \quad \text{(Eq. S1.1)}$$

$$TP_{bp,S} = IP_{bp,S} + FP_{pp,S} \quad \text{(Eq. S1.2)}$$

$$IC_S = ICb + ICo_S \quad \text{(Eq. S1.3)}$$

$$ICo_S = SSco + SSncoc \quad \text{(Eq. S1.4)}$$

$$GVA_{bp,S} = LCe + GMI_{bp,S} + GOS_{bp,S} \quad \text{(Eq. S1.5)}$$

$$GMI_{bp,S} = NMI_{bp,S} + CFCm_{MI,bp,S} \quad \text{(Eq. S1.6)}$$

$$NMI_{bp,S} + LCse + NOM_{MI,bp,S} \quad \text{(Eq. S1.7)}$$

$$NVA_{bp,S} = GVA_{bp,S} - CFCm \quad \text{(Eq. S1.8)}$$

$$NVA_{bp,S} = LCe + NMI_{bp,S} + NOS_{bp,S} \quad \text{(Eq. S1.9)}$$

$$NVA_{bp,S} = LCr + NOSr_{bp,S} \quad \text{(Eq. S1.10)}$$

$$LCr = LCe + LCse \quad \text{(Eq. S1.11)}$$

$$NOSr_{bp,S} = GOSr_{bp,S} - CFCm \quad \text{(Eq. S1.12)}$$

$$NOSr_{bp,S} = NOS_{bp,S} + NOM_{MI,bp,S} \quad \text{(Eq. S1.13)}$$

$$NOS_{bp,S} = NOM_{bp,S} + WPeu \quad \text{(Eq. S1.14)}$$

$$NOSr_{bp,S} = NOMr_{bp,S} + WPeu \quad \text{(Eq. S1.15)}$$

$$NOMr_{bp,S} = NOM_{bp,S} + NOM_{MI,bp,S} \quad \text{(Eq. S1.16),}$$

where subscript S is standard accounts, GVA_S represents gross value added, $TP_{bp,S}$ is total product at basic price, IC_S is intermediate consumption, $IP_{bp,S}$ is intermediate product, $FP_{pp,S}$ is final product at producer price, ICb is bought intermediate consumption, ICo_S is own intermediate consumption, SSco is own commercial intermediate consumption, SSncoc is own compensated non-commercial intermediate consumption, CFCm is consumption of manufactured fixed capital, LCe is employee labor cost, $GMI_{bp,S}$ is gross mixed income, $GOS_{bp,S}$ is the gross operating surplus, $CFCm_{MI,bp,S}$ is mixed income consumption of manufactured fixed capital, $NOS_{bp,S}$ is net

operating surplus, $NOSr_{bp,S}$. is refined net operating surplus, GOSr is revised gross operating surplus, GOSr is refined gross operating surplus, and $NOM_{bp,S}$ is the net operating margin.

The $NOSr_{bp,S}$ incorporates the value of the environmental work in progress used (WPeu) and omits the natural growth (NG). For this reason, the $NOSr_{bp,S}$ could present a bias in its estimation. This bias is quantified by the difference between the NG and WPeu values. The $NOMr_{bp,S}$ eliminates the WPeu bias, but does not avoid the NG omission bias. The $NOSr_{bp,S}$ measurement omission biases of the NG in the product and the WPeu in the cost are solved in our revised standard accounts (Sr). This revision is completed by incorporating the NG and WPeu into the $NOSr_{bp,S.}$ We then substitute the new value ($NOM_{bp,Sr}$) for the $NOSr_{bp,S}$ value and operate using the accounting identities below, arriving at the revised net operating margin at basic price ($NOM_{bp,Sr}$) of the revised standard accounts. Thus, after adding the adjustments described below to the $NOM_{bp,Sr}$, we link the $NOM_{bp,Sr}$ to the net operating margin at social price ($NOM_{bp,E}$) of the extended accounts:

$$GVA_{bp,Sr} = GVA_{bp,S} + NG - WPeu \quad \text{(Eq. S1.17)}$$
$$GOM_{bp,Sr} = GOSr_{bp,S} + NG - WPeu \quad \text{(Eq. S1.18)}$$
$$NOM_{bp,Sr} = NOSr_{bp,S} + NG - WPeu \quad \text{(Eq. S1.19)}$$
$$NOM_{bp,Sr} = NOMr_{bp,S} + NG \quad \text{(Eq. S1.20)}$$
$$NG = NOMei_{Sr} \quad \text{(Eq. S1.21)}$$
$$NVA_{bp,Sr} = GVA_{bp,Sr} - CFCm \quad \text{(Eq. S1.22)}$$
$$PT_{bp,Sr} = PT_{bp,S} + NG \quad \text{(Eq. S1.23)}$$
$$IC_{Sr} = ICb + ICo_S + WPeu \quad \text{(Eq. S1.24)}$$
$$NVA_{bp,Sr} = PT_{bp,Sr} - IC_{Sr} - CFCm \quad \text{(Eq. S1.25)}$$
$$NVA_{bp,Sr} = LCr + NOM_{bp,Sr} \quad \text{(Eq. S1.26)}$$
$$NOM_{bp,Sr} = GOM_{bp,Sr} - CFCm \quad \text{(Eq. S1.27)}$$
$$NOM_{bp,Sr} = NOMm_{bp,Sr} + NOMe_{bp,Sr} \quad \text{(Eq. S1.28)}$$
$$NOMm_{bp,Sr} = NOMmo_{bp,Sr} + NOMmi_{Sr} \quad \text{(Eq. S1.29)}$$
$$NOMe_{bp,Sr} = NOMeo_{bp,S} + NOMei_{Sr} \quad \text{(Eq. S1.30)}$$
$$ES_{bp,Sr} = NOMeo_{bp,S} + WPeu \quad \text{(Eq. S1.31),}$$

where subscript Sr signifies revised standard accounts, $GVA_{bp,Sr}$ represents gross value added, $NOMei_{Sr}$ is environmental investment net operating margin, $NOMe_{bp,Sr}$ is

environmental net operating margin, $NOMeo_{bp,S}$ is the ordinary environmental net operating margin, $GOM_{bp,Sr}$ is gross operating margin, $NOMm_{bp,Sr}$ is manufactured net operating margin, $NOMmo_{bp,Sr}$ is ordinary manufactured net operating margin, $NOMmi_{Sr}$ is investment manufactured net operating margin, $TP_{bp,Sr}$ is total product at basic price, IC_{Sr} is intermediate consumption, $NVA_{bp,sr}$ is net value added, PT_{Sr} is total product, and $ES_{bp,Sr}$ is actual ecosystem service at basic price.

In the *dehesa* farm case studies, self-employed labor cost (LCse) is used, mainly in livestock and hunting activities, and for this reason the standard accounts' estimates of the net value added at basic price ($NVA_{bp,S}$) incorporate the net mixed income at basic price ($NMI_{bp,S}$), in addition to the other two standard operating income components (employee labor cost (LCe) and the net operating surplus [$NOS_{bp,S}$). We separate $NMI_{bp,S}$ into the LCse (for details see Ovando et al., 2016) and the net operating surplus at basic price ($NOS_{bp,NMI,F,S}$). Furthermore, we estimate the named revised standard net operating surplus ($NOSr_{bp,S}$) as the sum of the $NOS_{bp,S}$ and $NOS_{bp,NMI,S}$. The $NOS_{Sbp,S}$ presents the biases incurred in the omissions of both the cost of the WPeu, as well as the product of natural growth (NG). We estimate the revised standard account's (Sr) net operating margin at basic price ($NOM_{bp,Sr}$) by overcoming the biases of the $NOSr_{bp,S}$. In order to do this, we add the NG and then subtract the WPeu from the $NOSr_{bp,S}$. Since the $NOS_{bp,S}$ contains the environmental work in-progress used (WPeu), we must separate the former into the named standard refined net operating margin ($NOMr_{bp,S}$) and WPeu. Revised standard accounts (Sr) do not change the ecosystem service value of standard accounts (S). However, Sr's do vary the added values and change the revised surpluses by the revised operating margins. Thus, the estimated $NOM_{bp,Sr}$ can be compared in a consistent way with the net operating margin at social price of the extended accounts ($NOM_{sp,E}$).

S2. Holm oak *dehesas* case studies extended accounts

The concepts and methods of extended accounts have been applied in previous publications of the authors in Campos et al. (2016, 2017, 2019), Caparrós et al. (2017), Ovando et al, (2016) and Oviedo et al. (2017). In this article we briefly describe the most novel aspects applied in the *dehesas* case studies in order to facilitate readers' comprehension of the text without the need to turn to published literature. The figures

and tables of results, as well as the supplementary texts, present exhaustively ordered the links of the elements that make up the results of the estimated economic variables.

S2.1 Grazing intermediate raw material

Grazing intermediate raw material refers to livestock's grazed fodder consumption during the *dehesa* case studies' accounting period. This grazed fodder includes all livestock that have been grazed in the *dehesas* case studies during the accounting period (Campos et al., 2016). Livestock grazing is valued in accordance with the environmental price of fodder, measured as the residual value of the grazing leasing net price of manufactured intermediate consumption, labor cost and capital user costs (consumption of manufactured fixed capital plus normal manufactured net operating margin) incurred by grazing activity management (Campos et al., 2016; 2017).

Grazing consumption by game species is recorded at a price of zero when it does not compete with the grazing demand of livestock in the local market. However, grazing consumption by game species is embedded in the price of the captured species' stumpage price when they are also valued at their environmental price. That is, it is consistent to not value the grazing consumption of game species so that double-counts are avoided while accounting. In accordance with the assumption that settled game are considered as wild biota, we value the game species' grazed fodder at zero price, and we substitute the latter by the environmental value of captured game at their environmental prices (Herruzo et al., 2016).

S2.2 Gross capital formation

The gross capital formation (GCF), in extended accounts, refers to the own-produced final products, consisting of durable finished products, gross fixed capital formation (GFCF) and work-in-progress goods (GWPF) accumulated for future final product consumption (FPc) at the closing of the period. The *dehesa* case studies mainly produce manufactured own-investments (GCFm); and environmental own-investment in the form of natural growth of forestry and game (NG).

S2.3 Total cost

The total production cost (TC) arising from economic activities is composed of bought or imputed intermediate consumption (IC), employee and self-employed labor

cost (LC) and consumption of fixed capital (CFC) at replacement cost. The intermediate consumption of the extended accounts incorporates, in addition to that of the standard accounts, the own auto-consumption of intermediate consumption of services (SSnca) and the environmental work in progress used (WPeu).

S2.4 Social price

The extended accounts estimate three types of gross value added (GVA): (i) at producer prices (GVA_{pp}), when only commercial intermediate services (ISSc) are included; (ii) at basic prices (GVA_{bp}), when compensated non-commercial intermediate services (ISSncc)[6] are included; and (iii) at social prices (GVA_{sp}), which includes the additional auto-consumption non-commercial intermediate services (ISSnca) (for ISSnc estimation details see Campos et al., 2017, 2019). Based on the extended production account, the GVA_{pp} is estimated as the difference between the total product at producer price (PT_{pp}) minus the intermediate consumption (IC) at bought or imputed prices:

$$GVA_{pp} = TP_{pp} - IC \quad \text{(Eq. S2.1)}$$

$$NVA_{pp} = GVA_{pp} - CFC \quad \text{(Eq. S2.2)}$$

$$GVA_{bp} = GVA_{pp} + ISSncc \quad \text{(Eq. S2.3)}$$

$$GVA_{sp} = GVA_{pp} + ISSnc \quad \text{(Eq. S2.4)}$$

$$ISSnc = ISSncc + ISSnca \quad \text{(Eq. S2.5)}$$

where CFC is consumption of fixed capital.

S2.5 Ordinary manufactured immobilized capital

The ordinary manufactured immobilized capital (IMCmo) is defined as the average annual investment of landowners, livestock owners and the government employed in the economic activities of the *dehesas* case studies. The IMCmo is estimated by the sum of opening manufactured fixed capital (FCmo) devoted to generating the total product consumption and ordinary manufactured working capital (WCmo), estimated at the value of half of the ordinary monetary cost minus the sales of final products sales and the operating compensations:

[6] The government compensation of non-commercial intermediate services (ISSncc) are estimated by the gross operating compensation (GOC).

IMCmo = FCmo + WCmo (Eq. S2.6)

S2.6 Environmental income

The extended and revised standard account's EI component of the environmental net operating margin (NOMe) includes the operating (NOMeo) and the investment net operating margins (NOMei). The EI component of the environmental asset gain (EAg) incorporates the natural growth (NG) minus the consumption of environmental fixed assets (CFCe). In these *dehesa* applications carbon emission services (SSe) have been registered as the only CFCe. The EAg is estimated by taking into account the revaluation of environmental asset (EAr) minus the extraordinary withdrawal of environmental asset destruction (EAwd) [7] and environmental asset withdrawal reclassification (EAwrc), valued at the opening of accounting period. The latter is an adjustment that avoids the double counting of woody natural growth (NG) and carbon final product consumption (FPcca) (Campos et al., 2017, 2019):

EI = NOMe + EAg (Eq. S2.7)

Eq. S2.7 can be regrouped and show the EI as the sum of the NOMeo and the change in environmental net worth (CNWe) (Campos et al., 2019). The latter is defined as the sum of NOMei and EAg:

NOMe = NOMeo + NOMei (Eq. S2.8)
NOMei = NG – CFCe (Eq. S2.9)
EI = NOMeo + NOMei + EAg (Eq. S2.10)
EAg = EAr – EAwd – EAwrc (Eq. S2.11)
EAwrc = NG/(1+ r) + FPcca/(1+r) (Eq. S2.12)
EI = NOMeo + CNWe (Eq. S2.13)
CNWe = NOMei+ EAg (Eq. S2.14),

where r is normal rate of discounting.

[7] In these dehesas case studies the EAwd is nil in the current period.

Rearranging Eq. S2.13 by adding and subtracting environmental work in progress used (WPeu), the EI is shown as the sum of ecosystem services and WPeu, adjusted to change of environmental net worth (CNWead):

$$CNWead = CNWe - WPeu \quad \text{(Eq. S2.15)}$$

$$EI = ES + CNWead \quad \text{(Eq. S2.16)}$$

S3. Holm oak *dehesas* case studies ecosystem services

S3.1 Ecosystem services accounting identities definitions

Based on the revised standard and extended accounts we estimate the total product consumption at the social price (TPc_{sp}), the ordinary manufactured total cost (TCmo) and the ordinary manufactured net operating margin ($NOMmo_{sp}$). We also estimate the ecosystem services at the social price (ES_{sp}) embedded in the PTc_{sp} of a single activity.

The production function contains all the natural and manufactured production factors which contribute to the value of the total product consumption at social price (TPc_{sp}) (Edens et al., 2013; Campos et al., 2019). The TPc_{sp} (eq. S3.1) has four manufactured and two environmental production factor components. The environmental work in progress used (WPeu) at the opening of the accounting period, valued at the environmental price (unitary resource rent), is an environmental intermediate consumption that is incorporated into the TPc_{sp}. The ordinary environmental net operating margin (NOMeo) valued at social price refers to the environmental fixed asset operating benefit embedded in the TPcsp. We are able to rearrange both sides of the equation (eq. S3.1) to show the second identities of TPcsp (eq. S3.2), as well as the two identities of actual ecosystem services at social price (ES_{sp}) in (eq. S3.3):

$$TPc_{sp} = ICmo^{8} + LCo + CFCmo + NOMmo + NOMeo + WPeu \quad \text{(eq. S3.1)}$$

$$TPc_{sp} = ICmo + LCo + CFCmo + NOMmo + ES_{sp} \quad \text{(eq. S3.2)}$$

$$ES_{sp} = NOMeo + WPeu \quad \text{(eq. S3.3)}$$

[8] The ICmo is the aggregated value of ordinary raw materials (RMmo) and ordinary services (SSmo).

It is assumed that the land and livestock owners accept the voluntary opportunity costs from the farmer activities. From this assumption it follows that farmers nearly obtain a normal ordinary manufactured net operating margin (NOMmon) on activities where opportunity cost accepted. The latter is estimated by a normal private profitability rate (r) multiplied by ordinary manufactured immobilized capital (IMCmo). For there to be a value on ecosystem services (ES_{sp}), its residual value must be greater than zero. This restriction does not work for a single product that has a production function with own ordinary intermediate consumption as the only ordinary manufactured total cost:

$NOMmon = r*IMCmo$ (eq. S3.4)

$ES_{sp} > 0$, if $TPc_{sp} - TCmo - NOMmo > 0$ (eq. S3.5)

If $ES_{sp} > 0$, then $TPc_{sp} = TCmo + NOMmo + ES$ (eq. S3.6)

If $ES_{sp} > 0$, then $ES = TPc - TCmo - NOMmo$ (eq. S3.7)

If $TPc - TCmo - NOMmo < 0$, then $ES = 0$ (eq. S3.8)

If $TPc - TCmo - NOMmo < 0$, then $ES < 0$ and $TCmo = ICmoo$ (eq. S3.9)

If ES is zero, then the residual ordinary manufactured net operating margin (NOMmor) is estimated by using the following accounting identities:

$NOMmor = TPc - TCmo$ (eq. S3.10)

If $ES = 0$, then $TPc = TCmo + NOMmor$ (eq. S3.11)

The user cost of the ordinary manufactured immobilized capital (IMCmouc) is estimated by:

$IMCmouc = CFCmo + NOMmo$ (eq. S3.12)

The existence of an ecosystem services (ES) value greater than zero requires the TPc to exceed the aggregate value of the ordinary manufactured total cost (TCmo) and the normal ordinary manufactured net operating margin (NOMmon). The residual ordinary manufactured net operating margin (NOMmor) is estimated when the ES equals zero, as expressed in Eq. S3.16:

ES > 0, if TPc – TCmo – NOMmon > 0 (Eq. S3.13)

ES = 0, if TPc – TCmo – NOMmon < 0 (Eq. S3.14)

If ES = 0, then TPc = TCmo + NOMmor (Eq. S3.15)

NOMmor = TPc – TCmo (Eq. S3.16)

For simplicity, we will avoid the repeated use of the definitions of the general concepts already discussed in the following developments of the estimation of ecosystem services of cork ok farms case studies single activities.

S3.2 Timber, cork and firewood final woody products ecosystem services

The current period final woody products consumed (harvested) includes timber, cork and firewood. These current period woody products consumed are valued before harvesting at market stumpage prices ($FPcw_{stp}$). The $FPcw_{stp}$ is assumed to be the first potential transaction suitable for measuring the environmental wood work in progress used (WPeuw) that comes from the withdrawal of environmental woody work in progress asset. The WPeuw is measured at opening current period by subtracting the current period silviculture ordinary manufactured total cost ($TCmow_{sil}$) and the normal ordinary manufactured net operating margin ($NOMmown_S$) from the closing $FPcw_{stp}$, which then is discounted by one period at the normal rate (r) of discounting. The woody environmental price (ep_w) is the woody harvest unitary resource rent of current period. The woody product after harvesting is valued at farm gate producer price ($FPcw_{pp}$).

The current-period woody ecosystem services (ESw) is measured by wood quantity consumed (q_{cw}) times its environmental price (ep_w). These ESw estimates equate to the WPeuw. The ordinary woody environmental net operating margin (NOMeow) is null because the woody product takes more than one period to be harvested. Thus, the ESw is obtained as a residual value; by definition the WPeuw is the ESw only if is a positive value. If WPeuw is a negative value, we consider that the ESw to be null:

$FPcw_{pp} = q_{cw} * pp_w$ (eq. S3.17)

$FPcw_{stp} = q_{cw} * stp_w$ (eq. S3.18)

$WPeuw = (FPcw_{stp} – TCmow_{SEL} – NOMmown_S)/(1+r)$ (eq. S3.19)

$ep_w = WPeuw / q_{cw}$ (eq. S3.20)

$WPeuw = q_{cw} * ep_w$ (eq. S3.21)

$ESw = WPeuw$ (eq. S3.22)

$NOMeow = 0$ (eq. S3.23)

S3.3 Grazing ecosystem services

The grazing commercial intermediate raw material consumed (IRMg) is estimated by the physical forage units consumed quantity (q_{cg}) multiplied by the livestock producer (market) grazing lease price (stp_g). Browses and shrubs grazing consumption (IRMg) may incorporate grazing work in progress used (WPeug), but because there is no data we cannot measure it explicitly. Thus, NOMeog could include the WPeug:

$IRMg = q_{cg} * stp_g$ (eq. S3.24)

$NOMeog = IRMg - TCmog\_NOMmogn$ (eq. S3.25)

$ep_g = NOMeog/q_{cg}$ (eq. S3.26)

$NOMeog = q_{cg} * ep_g$ (eq. S3.27)

$ESg = NOMeog$ (eq. S3.28)

$WPeug = 0$ (eq. S3.29)

S3.4 Conservation forestry and fire services

In farmer conservation forestry and government fire service activities, the estimation of ecosystem services is not applicable because only manufactured production factors have registered their production functions.

S3.5 Hunting ecosystem services

Hunting ecosystems services (ESh) are composed by hunting captures (IRMh) of migrant species and settled non-inventoried species valued at stumpage price (stp_h), as well as the captures (WPeuh) of settled inventoried species, valued at environmental price (ep_h):

$IRMh = q_{ch} * stp_h$ (eq. S3.30)

$RMmo = IRMh$ (eq. S3.31)

$FPch_{pp} = q_{ch} * pp_h$ (eq. S3.32)

$WPeuh = (FPch_{stp} - TCmoh_{M}\_NOMmohn_{M})/(1+r)$ (eq. S3.33)

$ep_h = WPeuh / q_{cw}$ (eq. S3.34)

$WPeuw = q_{cw} * ep_w$ (eq. S3.35)

$TPc_{pp} = IRMh + FPch_{pp}$ (eq. S3.36)

$TPc_{pp} = TCmoh + WPeuh + NOMeoh + NOMmh$ (eq. S3.37)

$TCmoh = RMmohb + RMmoho + SSmohb + LCoh + CCFmoh$ (eq. S3.38)

$RMmoho = IRMh + IRMgh$ (eq. S3.39)

$NOMeoh = IRMh$ (eq. S3.40)

$ESh = WPeuh + NOMeoh$ (eq. S3.41)

S3.6 Commercial recreation ecosystem services

There is no data available for estimating the potential ecosystem services of the commercial recreation activity.

S3.7 Residential housing ecosystem services

There is no data available for estimating the potential ecosystem services of the residential housing commercial activity.

S3.8 Livestock

There is no data available estimating the potential ecosystem services of the livestock activity.

S3.9 Crops

There is no data available for estimating the potential ecosystem services of the agricultural activity.

S3.10 Private amenity

Standard accounts do not apply to amenity activity ecosystem services. If we accept that residential housing today only responds to family enjoyment and, therefore, does not fulfill a function of rendering services to other activities, then the rental price of residential housing is the minimum commercial value of the amenity service consumed by landowner. This value of the residential housing commercial intermediate service (ISScrh) has a counterpart, of equal value, in its use in the form of input of intermediate consumption of own service (SScrho) of the amenity activity, which the SNA should conceptually register, and also its value to register the final product consumed as a private amenity consumption (FPpa). The amenity SNA is valued at the

the cost of commercial production, which does not register any cost other than the own service input of the residential housing, and therefore the ecosystem service is null:

In the extended accounts the residual ordinary environmental net operating margin (NOMepao) is a potential positive/negative value of the accounting period:

$NOMopa = FPpa_E - SSncoa$ (eq. S3.42)

$NOMmopan = r*IMCmopa$ (eq. S3.43)

$NOMepao = NOMopa - NOMmopan$ (eq. S3.44)

$ESpa = NOMepao$ (eq. S3.45)

S3.11 Public recreation

The SNA records government spending on public recreational service activity in the production accounts of the institutional services and government economic sectors. Ordinary total cost (TCrco), included in the value of the final product consumed (FPrc), is separated from and own account investment total cost (TCrci), which is recorded as final product of gross fixed capital formation (GFCFrc) and the former. Although the SNA does not attribute a normal margin to the economic activities of the government, we give this margin to the public recreational service due to its consumption's similarity to the commercial recreational service activity provided by private companies. The criterion of the revised SNA with no imputation of the normal ordinary net operating margin (NOMrcon) in the FPrc value results in an ecosystem service value of zero.

In extended accounts the general ecosystem equation applies, given a a residual value that is positive or zero for ecosystem services:

$ESrc = TPcrc - TCmorc - NOMmorcn$ (eq. S3.46)

$ESrc = NOMeorc$ (eq. S3.47)

S3.12 Mushrooms

We have not recorded the mushroom collection by commercial companies or recreational visitors who had previously paid an access fee. In the region of Andalusia, both forms of access by payment of the resource rent to the landowner are still incipient. In Andalusia, we observe that private land owners allow the free access of recreational mushroom collectors to their farms. In this region, the Andalusian government expenses of mushroom regulation are negligible. The value of the mushroom final product

collected (FPcmu) is, in this case, the only record of the product in the production account. However, the cost side does not include the labor cost of the collectors for accepting that their time dedicated to the activity that has as a counterpart to the recreational enjoyment and, therefore, the appropriation of the mushroom is a direct gift of nature. In this case, the market value of the product at the farm gate is also the value of the ecosystem service (ESmu) of the mushrooms collected by the recreational visitors. The SNA records the value of the recollection of recreational visitors in the institutional sector of households.

$$ESmu = TPcmu - TCmomu - NOMmomun \quad \text{(eq. S3.48)}$$

$$ESmu = NOMeomu \quad \text{(eq. S3.49)}$$

S3.13 Carbon

The SNA does not account for greenhouse carbon service mitigation due to the woody vegetation of the trees and shrubs' natural growth in the cork oak farms case studies. In the case of extended accounts, woody natural growth is accounted as ecosystem services and we assumed there is no ordinary manufactured cost in the accounting year:

$$ESca = FPcca \quad \text{(eq. S3.50)}$$

S3.14 Landscape

The SNA landscape final product consumed ($FPcla_S$) of landscape service conservation activity is the government-purchased manufactured total ordinary cost (TCbola). This last cost of the SNA is composed of the intermediate consumption purchased ($ICbola_{SNA}$), the ordinary labor cost (LCola) and the ordinary consumption of fixed capital (CFCola). In the AAS, the final product consumed of landscape (FPcla) is estimated by the ordinary manufactured total cost (TCmola), which includes own intermediate consumption of donation along with the auto-consumption of non-commercial intermediate services (SSncooa/d) plus the consumer additional willingness to pay (WTPlaa) in order to avoid future loss of landscape service value. The FPcla can also be estimated from the FPclac minus the intermediate consumption of own ordinary services (SSncoola/d) and the WTPlaa. By definition, regardless of calculation procedures, the SNA landscape net operating margin ($NOMola_{SNA}$) is null, and from

this we then derive that the landscape ecosystem service ($ESla_S$) is also null. In extended accounts, the general ES residual valuation applies:

$$ESla = TPcla - TCmola - NOMmolan \quad \text{(eq. S3.51)}$$

$$ESla = NOMeola \quad \text{(eq. S3.52)}$$

S3.15 Threatened biodiversity

The SNA depends on the final product consumed ($FPcbi_S$) of the landscape service conservation activity the government purchased manufactured total ordinary cost (TCmobi). This final cost of the SNA is composed of the intermediate consumption purchased ($ICmobi_S$), the ordinary labor cost (LCobi) and the ordinary consumption of fixed capital (CFCobi). In the AAS the final product consumed of landscape (FPcbi) is estimated by the ordinary manufactured total cost (TCmobi) plus the consumer additional willingness to pay (WTPbia) to avoid future loss of landscape service value. The $FPcbi_S$ can also be estimated from the FPcbi minus the intermediate consumption of own ordinary services (SSncoobi) and the WTPbia. By definition, regardless of the calculation procedure, the landscape net operating margin ($NOMbio_{SNA}$) is null, and from this we derive that the landscape ecosystem service ($ESbi_S$) of the SNA is also null. In extended accounts the general ES residual valuation applies:

$$ESbi = TPcbi\ TCmobi - NOMmobin \quad \text{(eq. S3.53)}$$

$$ESbi = NOMeobi \quad \text{(eq. S3.54)}$$

S3.16 Environmental water

The SNA calculates the manufactured water final product consumed ($FPcwa_S$). This is regulated in the public basins by the purchased manufactured ordinary total cost (TCmowa), which integrates the manufactured intermediate consumption (ICobwa), the labor cost (LCowa) and consumption of ordinary fixed capital (CFCowa). This SNA criterion of valuing the $FPcwa_{SNA}$ by its total cost results in null values for both the net operating margin (NOMwa) and an ecosystem services ($ESwa_S$) from the government water authority, including their management of dam system of the river basins.

The service of the water ecosystem in the revised standard accounts (SNAr) has a positive value due to its consumption by irrigated crops. The hedonic price method of land can separately offer the value for the basket of individual assets. These assets

consist of the market price of the land irrigated with the water supplied by the public reservoirs. Due to the the amounts of water granted by the government to the irrigated land, the manufactured water management costs paid to the government and previously known market prices of the land, the environmental asset price of the water (pwei) can be estimated by multiplying the value by the amount of water granted for irrigation of agricultural crops (qwei). This offers the value of the environmental asset of the water per unit of irrigated area (Cwaei) and, subsequently also its value per physical unit of available water granted by the government. In this case, we need to estimate the environmental price of the water flow consumed in the irrigation of agricultural land, assuming a normal real rate of return (r), in order to estimate the value of the final production of environmental water (FPewaci) in the irrigated lands with water from public reservoirs. Recorded superficial runoff of rainwater by vegetation type upstream reaches the reservoirs and its economic consumption coefficient is obtained by the economic quantities of water in each farm (qwai). In the region of Andalusia, the surface runoff water which is stored in reservoirs and used to irrigate agricultural crops represents 85% of the final total water consumed (qwaec) by commercial users. The remaining 15% is consumed by industry, services and household sectors:

$$qwaei = i*qwaec \quad \text{(eq. S3.55)}$$

$$Cwei = qwaei*pwaei \quad \text{(eq. S3.56)}$$

$$FPwaeci = r*Cwaei \quad \text{(eq. S3.57)}$$

The estimate of the water environmental final product consumed (FPwaec), regulated in the reservoirs in the AAS, accepts the notion that 15% of economic users other than the owners of irrigated land would pay at least the environmental price of the water for irrigation as estimated by the hedonic price method. The FPcwaei of the SNA can also be estimated by multiplying the FPcwae of the AAS directly by the coefficient i of the environmental economic water consumed by irrigation:

$$FPcwae_{SNA} = FPcwaei \quad \text{(eq. S3.58)}$$

$$FPcwaei = i*FPcwe \quad \text{(eq. S3.59)}$$

S4. Holm oaks *dehesas* case studies total income measurement

The primary total income (TI) result is represented by the sum of the net value added at social price (NVA_{sp}) and the capital gain (CG) (Fig. S3). The NVA_{sp} is measured as the balancing item of the production account (Table S11). The CG is derived from the adjusted capital revaluation (Tables S7-S8). We reorganize this primary total income accounting identity in order to present it as the returns from the production factors of land environmental asset, labor and immobilized manufactured capital. These labor and total capital services returns are noted, respectively, by the environmental income (EI), the labor cost (LC) and the manufactured capital income (CIm) (Figs. S3).

We reorganize the total income primary identity in order to present it according to its conceptual definition shown in section 2 of the main text, where it is demonstrated as the sum of the net consumption of the accounting period (measured by the total product consumed minus intermediate consumption) and the change of the net worth (Fig. S4)[9].

The Fig. S3 shows the total income obtained from the application of the extended accounts in the holm oak *dehesas*. In Fig. S3, on the left side, above the total income boxes, the six components of the total product consumed are shown. Among the individual components of the total product consumed, intermediate raw materials and other final products have lower comparative values. On the other side of things, intermediate services (Table S11, Figs. 1-2) and auto-consumed, sold and public final products (Table S11, Figs. 1-S4) have outstanding relative weights.

In the center of Fig. S4, above the total income boxes, the negative value of the change in net worth is shown, which can be attributed to the fact that the positive net investment is significantly lower than the capital loss in the current period. The latter is mainly due to the fall in the price of land and buildings in 2010.

The right side above the total income boxes in Figs. S3-S4 shows the intermediate consumption. It can be seen that the latter includes own intermediate consumption as its highest value component (Fig. S3-S4, Table S11), although bought intermediate consumption and the work in progress used follow with close values.

[9] The extended accounts do not include financial accounts and for this reason the change in environmental net worth refers exclusively to the environmental asset of the holm oaks *dehesas* case studies.

The three components on the line above the total income in Fig. S4 represent the total product consumed minus the intermediate consumption at social prices along with the negative value of the change in net worth in the accounting period.

The portion below the total income box in Fig. S3 shows the factorial distribution of the latter. The manufactured capital income offers a negative result mainly due to the depreciations of buildings in the current period (Tables S7-S8).It can be observed that the net environmental operating margin significantly exceeds the loss of environmental assets. This negative result of the environmental asset gain is mainly due to the depreciation of the land price in the accounting period.

Extended account farmer intermediate raw materials and services contribute 15.8% and 73.1% repectively to the *dehesas* total intermediate product. Farmer commercial and non-commercial intermediate services represent 6.5% and 80.2% of the total of them (Fig. 1, Tables S7-S8-S11).

The 88.5% of the non-commercial intermediate services are produced by hunting and livestock activities, which will be used up as own intermediate consumption of services by private amenity activity (Fig. 2, Tables S7-S8-S11-S12). Own intermediate consumption of services is used up by the farmer´s amenity auto-consumption activity (accounts for 71%) and the landscape activity (accounts for 28.6%) (Fig. 2, Table S11). The livestock amenity non-commercial intermediate services are 2.3 times larger than the government livestock compensation non-commercial intermediate services (Table S11). The farmers' willingness-to-pay for amenity intermediate services is notably greater in the case of animal management than it is for amenity intermediate services for conservation forestry services (Fig. 2). Grazing intermediate product consists of 65.3% fodder and 34.7% auto-consumed intermediate services (Table S11). The grazing is livestock own intermediate consumption valued at imputed market lease price and the hunting species' grazed natural fodder is own intermediate consumption valued at zero price (Fig. S5). Thus, the substitute positive value of hunting species grazed natural fodder is the simulated permanent period hunting captures market lease value (Campos et al., 2019).

Farmer´s final product consumed is 2.0 times the government one (Tables S11-S12). Amenity, livestock and hunting activities respectively represent 54.1%, 32.9% and 5.4% of the farmer total final product consumed, while landscape, water and carbon activities, in regards to percentages of the government total final product consumed, make up, respectively 33.6%, 30.5% and 18.4% of the value (Table S12). Livestock and

hunting make up 73.5% and 11.3% of final products sold. Farmer final amenity service represents 98.2% of total auto-consumption (Table S11).

Livestock and hunting gross capital formation *(*GCF) make up 84.9% and 5.8%, respectively, of the total gross capital formation (Table S11). Manufactured gross capital formation is 18.5 times natural growth represented by cork, firewood and settled inventoried hunting species (Table S11). There is not grazing gross capital formation accounted in this *dehesas* research.

The total ordinary cost is 13.8 times the total investment cost for own account (Table S12). The farmer total cost is 5.3 times the total cost of the government (Table S12). Intermediate consumption of raw materials has a lower value than those of the services (Tables S11).

Supplementary figures for

Uncovering the hidden ecosystem services embedded in environmental incomes: Testing experimental extended accounts in *dehesas* of holm oak woodlands, Andalusia-Spain

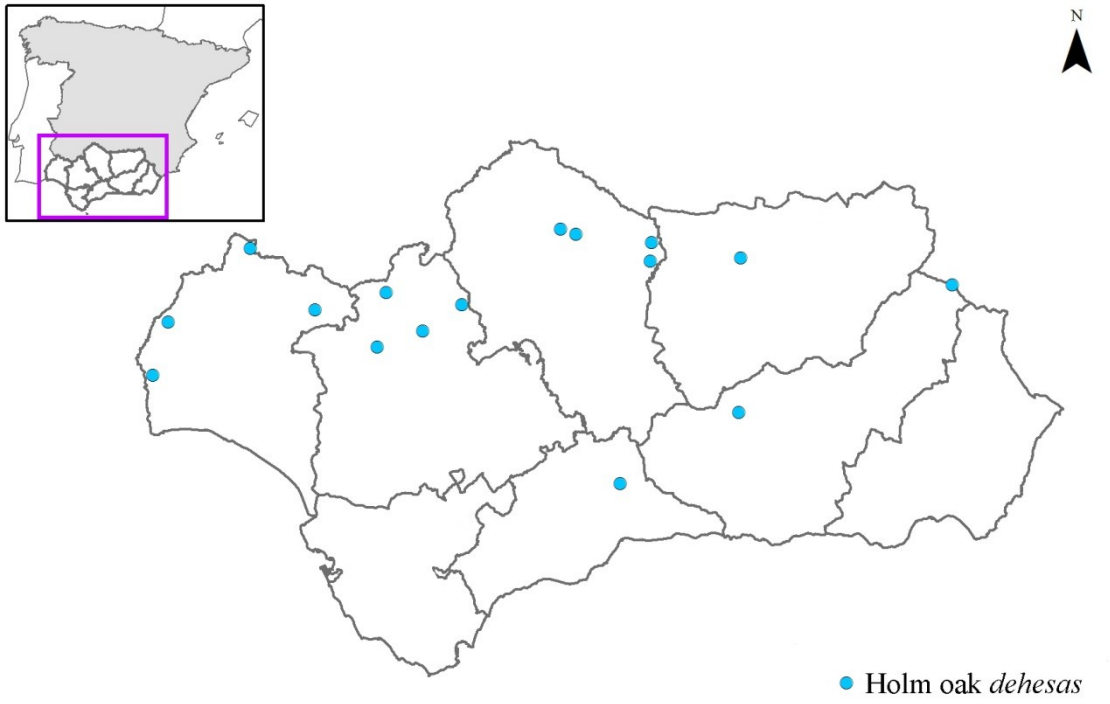

Figure S1. Holm oak *dehesas* case studies location map in Andalusia, Spain.

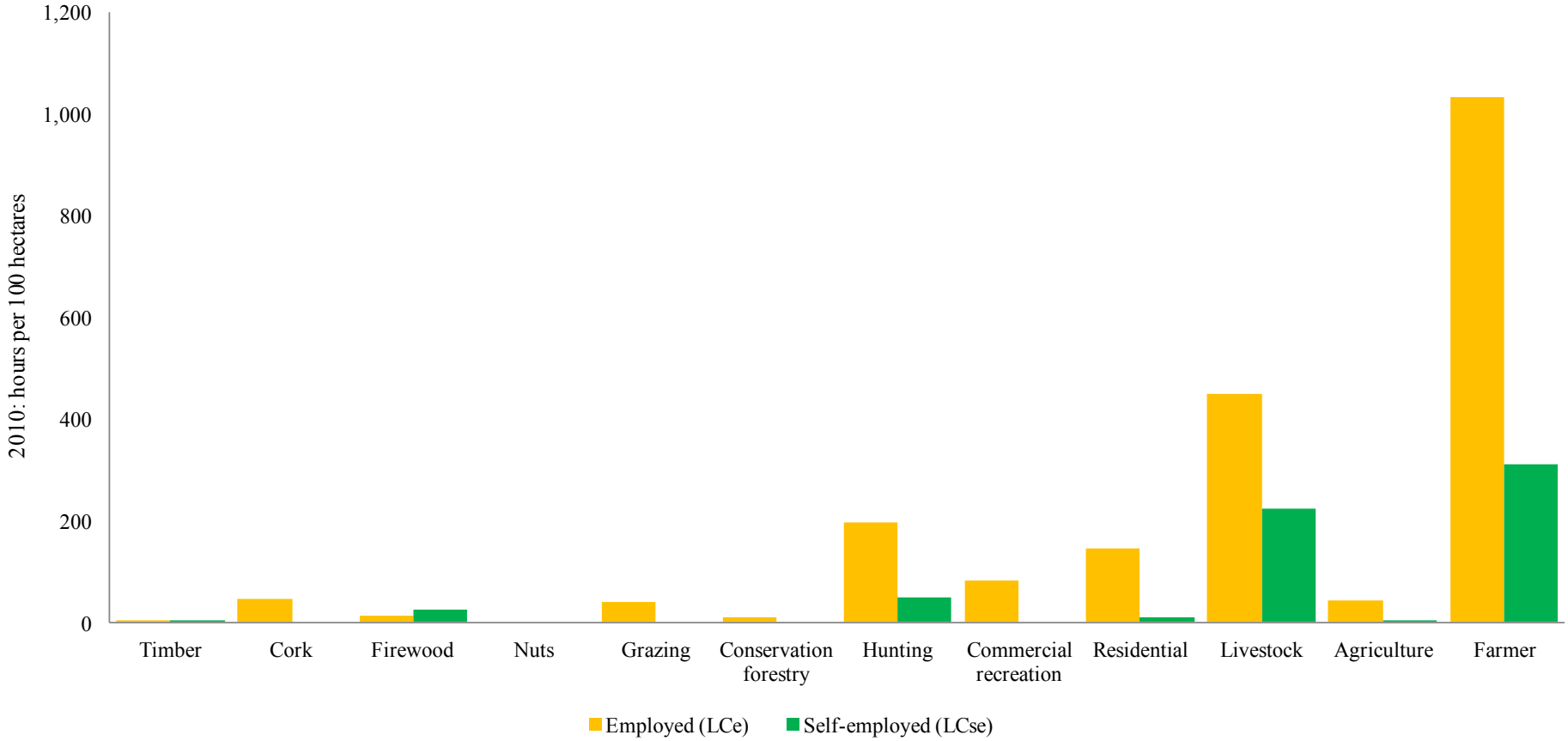

Figure S2. Holm oak *dehesas* case studies farmer labor demand in Andalusia, Spain (2010: hours per 100 hectares)

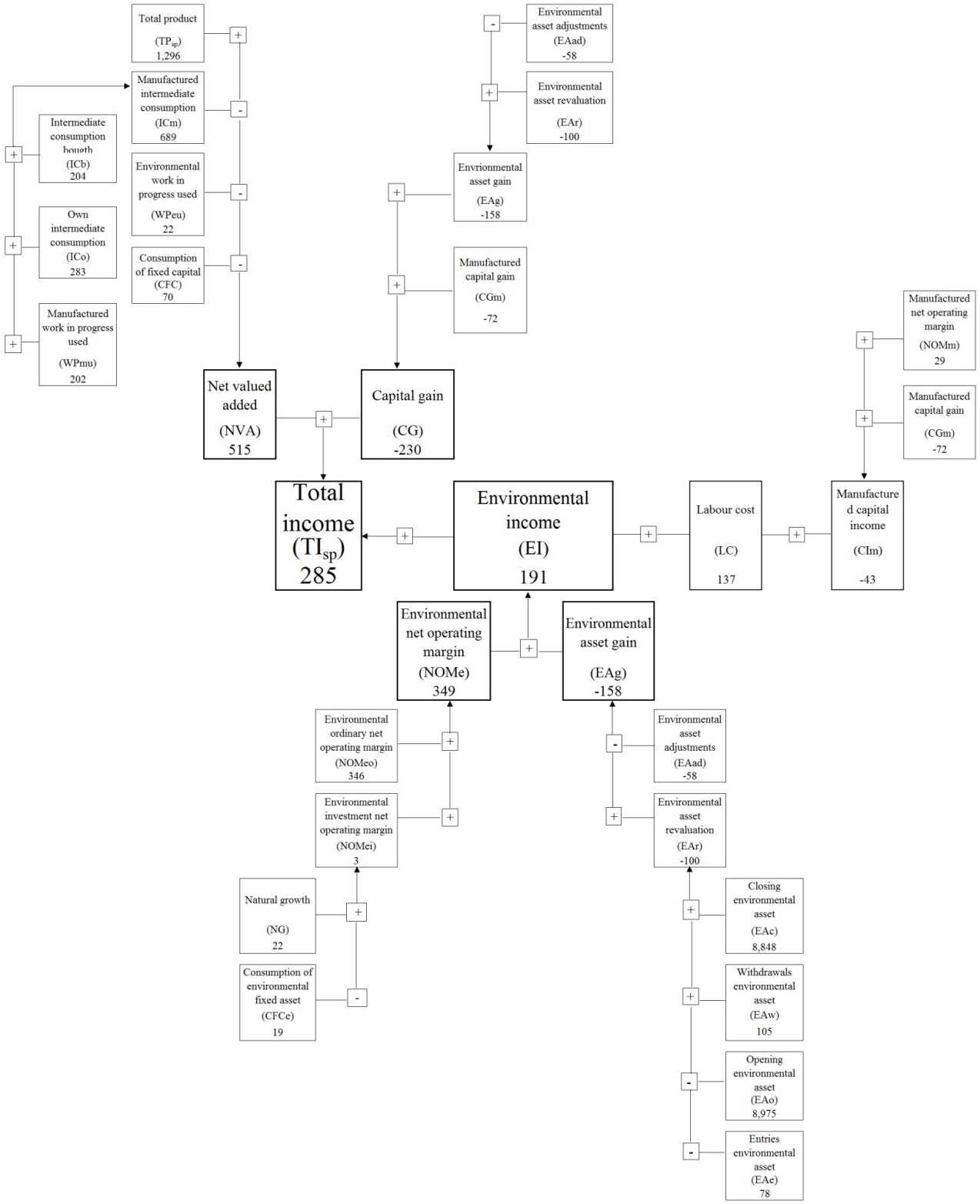

Figure S3. Holm oak *dehesas* case studies extended accounts farms total income at social prices: net value added and capital gain (2010: €/ha).

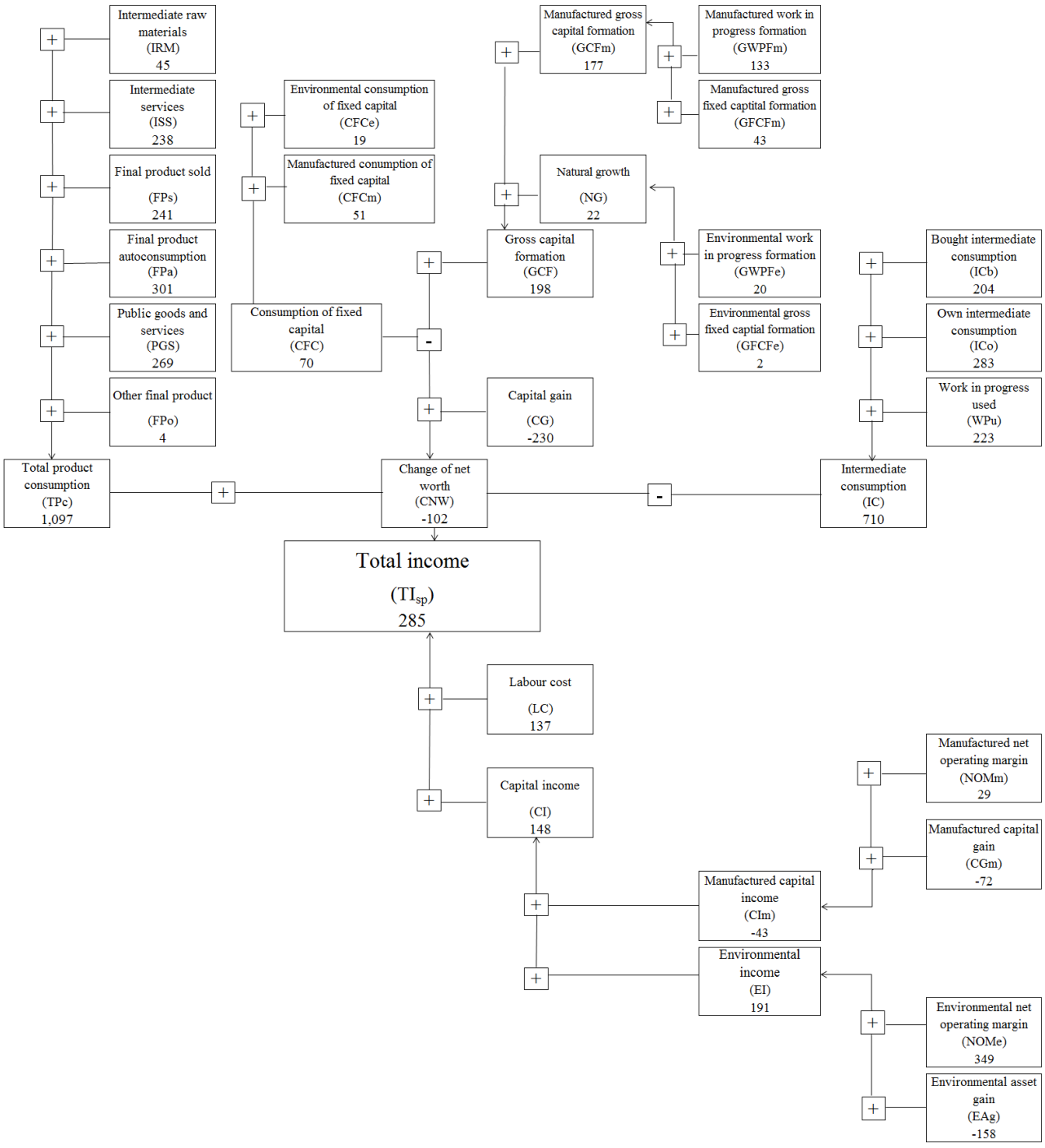

Figure S4. Holm oak *dehesas* case studies extended accounts farms total income at social prices: net product consumption and change of net worth (2010: €/ha).

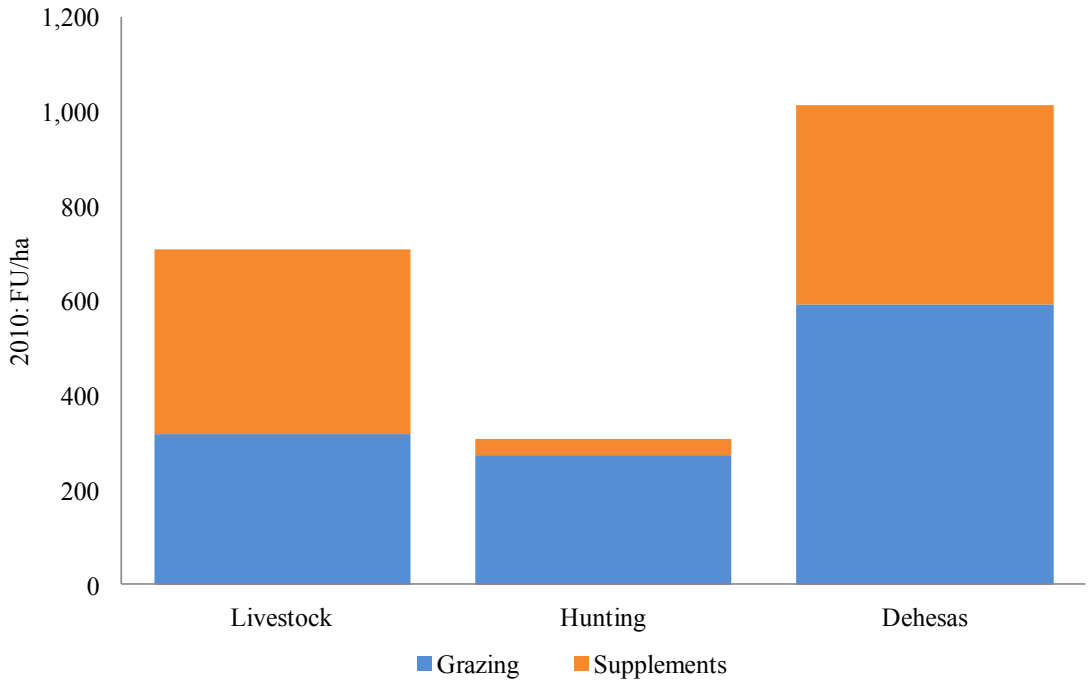

Figure S5. Holm oak *dehesas* case studies grazing and supplemented animal fodder in Andalusia, Spain (2010: FU/ha).

Supplementary tables for

Uncovering the hidden ecosystem services embedded in environmental incomes: Testing experimental extended accounts in *dehesas* of holm oak woodlands, Andalusia-Spain

Table S1. Holm oak *dehesas* case studies canopy cover fraction in Andalusia, Spain (2010).

Class	Surface (ha)	Canopy cover fraction (%)
1. Open woodland	7,066	34.0
2. Coniferous	678	11.9
3. Others[(1)]	297	5.9
4. Shrubland	471	
5. Grassland	266	
6. Agricultural	196	
7. Others[(2)]	58	
Dehesas	9,032	

Notes: [(1)] Includes riparian forests, other species and mix oaks-conifers forests and eucalyptus. [(2)]Infraestructure and unproductive surface.

Table S2. Holm oak *dehesas* case studies labor demand in Andalusia, Spain (2010).

Class	Employees			Self-employees			*Dehesas*		
	Quantity h/ha	Wage rate €/h	Labor cost €/ha	Quantity h/ha	Wage rate €/h	Labor cost €/ha	Quantity h/ha	Wage rate €/h	Labor cost €/ha
1. Landowner	10.3	9.5	98.2	3.1	1.0	3.1	13.4	7.5	101.4
1.1 Timber	0.0	6.5	0.2	0.0			0.0	4.4	0.2
1.2 Cork	0.5	17.6	8.1				0.5	17.6	8.1
1.3 Firewood	0.1	16.3	2.0	0.2	4.9	1.2	0.4	8.8	3.2
1.4 Nuts									
1.5 Grazing	0.4	12.5	5.1				0.4	12.5	5.1
1.6 Conserv. forestry	0.1	12.4	1.2				0.1	12.4	1.2
1.7 Hunting	2.0	9.9	19.6	0.5	0.7	0.3	2.5	8.0	19.9
1.8 Comm. recreation	0.8	6.9	5.6				0.8	6.9	5.6
1.9 Residential	1.5	6.8	10.0	0.1	1.3	0.1	1.6	6.5	10.1
1.10 Livestock	4.5	9.4	42.6	2.2	0.6	1.4	6.7	6.5	44.0
1.11 Agriculture	0.4	8.7	3.9	0.0			0.5	8.5	3.9
2. Government	1.7	21.2	35.4				1.7	21.2	35.4
2.1 Government forestry	1.0	21.0	22.0				1.0	21.0	22.0
2.2 Recreation	0.2	22.9	4.0				0.2	22.9	4.0
2.3 Mushrooms	0.0	21.4	0.1				0.0	21.4	0.1
2.4 Landscape	0.3	21.0	5.7				0.3	21.0	5.7
2.5 Biodiversity	0.2	21.0	3.6				0.2	21.0	3.6
Total (1+2)	12.0	11.1	133.6	3.1	1.0	3.1	15.1	9.1	136.7

Table S3. Holm oak *dehesas* case studies physical indicators in Andalusia, Spain (2010).

Class	Unity	Useful land (ha)	Quantity	Quantity/ha
1. Timber				
1.1 Natural growth	m^3	790	1,759	2.2
2. Cork				
2.1 Natural growth	t	341	260	0.8
2.2 Extraction	t	341	91	0.3
3. Firewood				
3.1 Natural growth	m^3	6,906	6,655	1.0
3.2 Extraction	m^3	6,906	1,605	0.2
4. Acorn	t	6,361	650,348	102.2
4.1 Commercial	FU	6,361	641,366	100.8
4.2 Free	FU	6,361	8,982	1.4
5. Forage unit	FU	9,032	8,515,546	942.8
5.1 Grazing	FU	9,032	4,698,210	520.2
Commercial	FU	9,032	2,729,836	302.2
Livestock	*FU*	*9,032*	*2,176,316*	*241.0*
Hunting	*FU*	*9,032*	*553,520*	*61.3*
Free	FU	9,032	1,968,373	217.9
Livestock	*FU*	*9,032*	*279,463*	*30.9*
Hunting	*FU*	*9,032*	*1,688,910*	*187.0*
5.2 Supplements	FU	9,032	3,817,337	422.6
Livestock	FU	9,032	3,518,610	389.6
Hunting	FU	9,032	298,727	33.1
6. Hunting captures				
6.1 Red deer	he	9,032	672	7.4(*)
6.2 Wild boar	he	9,032	162	1.8(*)
7. Livestock stock				
7.1 Females				
Bovine	he	9,032	1,004	11.1(*)
Ovine	he	9,032	1,718	19.0(*)
Caprine	he	9,032	1,306	14.5(*)
7.2 Birth				
Bovine	he	9,032	501	5.5(*)
Ovine	he	9,032	1,359	15.0(*)
Caprine	he	9,032	1,077	11.9(*)
7.3 Sales				
Bovine	he	9,032	336	3.7(*)
Ovine	he	9,032	1,278	14.1(*)
Caprine	he	9,032	1,075	11.9(*)
Porcine	arrobas	9,032	13,273	1.5
7.4 Ageing (breeders)				
Bovine	he	9,032	145	1.6(*)
Ovine	he	9,032	200	2.2(*)
Caprine	he	9,032	253	2.8(*)
8. Residential	m^2	9,032	4,308	47.7(*)
9. Recreation	visits	9,032	14,026	1.6
10. Mushrooms	kg	9,032	21,443	2.4
11. Carbon				
11.1 Fixation	t CO_2	8,778	32,584	3.7
Wooded	t CO_2	8,041	19,472	2.4
Shrubland	t CO_2	737	13,112	17.8
11.2 Emissions	t CO_2	8,778	12,505	1.4
Wooded	t CO_2	8,041	9,145	1.1
Shrubland	t CO_2	737	3,361	4.6
11.3 Net fixation	t CO_2	8,778	20,079	2.3
Wooded	t CO_2	8,041	10,328	1.3
Shrubland	t CO_2	737	9,751	13.2
12. Threatened species	nº	9,032	89	1.0(*)
13. Water	m^3	8,974	72,941,762	8,128
13.1 Intermediate production	m^3	8,974	38,205,647	4,257
Evapotranspiration	m^3	8,974	38,263,025	4,264
Negative variation	m^3	8,974	57,377	6
13.2 Final product	m^3	8,974	34,736,115	3,871
Runoff	m^3	8,974	21,025,202	2,343
Ecological	*m^3*	*8,974*	*14,922,446*	*1,663*
Economic	*m^3*	*8,974*	*6,102,756*	*680*
Deep aquifer recharge	m^3	8,974	12,613,293	1,406
Positive variation	m^3	8,974	1,097,619	122

Abbreviations: m^3 is cubic meters; t is ton; FU is forage unit; he is head; m^2 is square meter; kg is kilograms; tCO_2 is equivalent carbon dioxide ton and u is unit of threatened wild species.

(*)These indicators are expressed in their unity per 100 hectares.

Note: arroba it's the gain of weight of pigs during montanera, 1 arroba is equal at 11.5 kilograms

Table S4. Holm oak *dehesas* case studies Iberian pig Montanera season in Andalusia, Spain (2010).

Dehesa code	Surface	Weight of Iberian pigs in Montanera		Forage unit consumption		Montanera duration	Average number of Iberian pigs in Montanera per year and *dehesa*
		Entries	Withdrawals				
	ha	Arrobas	Arrobas	FU	FU/ha	Months	Heads
Dehesa D1	179	10.1	14.6	19,039	106.5	4	62
Dehesa D2	740	7	15	120,629	163.1	5	292
*Dehesa D*3	2,010	9.5	14.2	375,219	186.7	4	1,172
Dehesa D8	211	9	14	45,442	215.5	4	132
Dehesa D9	306	9	14	33,393	109.1	5	97
Dehesa D10	356	10.2	14	37,414	105.2	4	143
Dehesa D14	710	7.2	9.3	26,357	37.1	3	182
*Dehesa D*16	298	8.5	14.3	4,699	15.8	5	13
Total	4,809			662,194	137.7		2,093
Mean value	601	8.8	13.7	82,774	117.4	4	262

Table S5. Holm oak *dehesas* case studies farmer revised standard accounts summary of production, income generation, accumulation and capital in Andalusia, Spain (2010: €/ha).

Class	Timber	Cork	Firewood	Nuts	Grazing	Conserv. forestry	Hunting	Comm. recreation	Residential	Livestock	Agriculture	Amenity	Farmer
	1	2	3	4	5	6	7	8	9	10	11	12	13=∑1-12
1. Total product consumption (TPc_{bp})		13.5	9.8		28.2	1.6	47.8	10.1	18.1	213.7	4.0	14.0	360.8
1.1 Intermediate product (IP_{bp})					27.6	1.6	18.0		14.0	33.9	0.8		96.1
1.1.1 Raw materials (IRM)					26.4		18.0						44.4
1.1.1.1 Grass and browse (IRMgb)					12.6								12.6
1.1.1.2. Acorn (IRMa)					13.7								13.7
1.1.1.3 Recreational standing game hunted (IRMh)							18.0						18.0
1.1.2 Services (ISS)					1.3	1.6			14.0	33.9	0.8		51.7
1.1.2.1 Commercial (ISSc)						1.6			14.0				15.6
1.1.2.2 Compensated (ISSncc)					1.3					33.9	0.8		36.0
1.2 Final product consumed (FPc_{pp})		13.5	9.8		0.6		29.7	10.1	4.0	179.8	3.2	14.0	264.7
2. Revised ordinary intermediate consumption ($ICos_{r}$)	0.1	8.8	3.1		5.9	0.4	55.6	7.1	1.6	168.3	2.7	14.0	267.8
2.1 Manufactured bought (ICmob)	0.1	0.7	1.0		5.9	0.4	21.1	7.1	1.6	146.9	2.7		187.5
2.2 Manufactured own (ICmo)							22.9			21.5		14.0	58.4
2.3 Environmental work in progress used (WPeu)		8.1	2.1				11.6						21.8
3. Revised ordinary labor cost (LCor)	0.2	8.1	3.2		5.1	1.2	19.8	5.6	8.2	44.0	3.9		99.3
3.1 Employee (LCeor)	0.2	8.1	2.0		5.1	1.2	19.4	5.6	8.0	42.6	3.9		96.2
3.2 Self-employed (LCseor)			1.2				0.3		0.1	1.4			3.1
4. Ordinary consumption of manu. fixed capital (CFCmo)	0.1	0.5	0.2		2.6	0.1	7.7	4.2	13.8	14.8	2.6		46.6
5. Ordinary net operating margin ($NOMo_{bp,S}$)	-0.4	-3.9	3.2		14.6	-0.1	-35.4	-6.8	-5.5	-13.4	-5.2		-52.9
5.1 Manufactured net operating margin ($NOMmo_{bp,S}$)	-0.4	-3.9	3.2		-10.6	-0.1	-53.4	-6.8	-5.5	-13.4	-5.2		-96.1
5.2 Environmental net operating margin ($NOMeo_{S}$)					25.2		18.0						43.2
6. Revised ordinary net value added ($NVAo_{bp,Sr}$)	-0.2	4.2	6.5		19.7	1.1	-15.6	-1.2	2.7	30.6	-1.3		46.4
7. Revised gross capital formation (GCF_{Sr})	0.2	9.7	0.4				11.6		2.3	-49.8	0.7		-24.9
7.1 Manufactured (GCFm)							0.3		2.3	-49.8	0.7		-46.5
7.2 Natural growth (NG)	0.2	9.7	0.4				11.3						21.6
8. Investment intermediate consumption (ICmib)							0.1		0.4		0.7		1.2
9. Investment labor cost (LCi)							0.1		1.9		0.0		2.1
10. Investment consumption of manu. fixed capital (CFCmi)													
11. Revised investment net operating margin ($NOMi_{Sr}$)	0.2	9.7	0.4				11.3		0.0	-49.8	0.0		-28.2
11.1 Manufactured net operating margin (NOMmi)									0.0	-49.8	0.0		-49.8
11.2 Environmental net operating margin ($NOMei_{Sr}$)	0.2	9.7	0.4				11.3						21.6
12. Revised investment net value added ($NVAmi_{Sr}$)	0.2	9.7	0.4				11.5		1.9	-49.8	0.0		-26.1
13. Revised total product ($TP_{bp,Sr}$)	0.2	23.2	10.2		28.2	1.6	59.4	10.1	20.4	163.9	4.6	14.0	335.8
14. Revised intermediate consumption (IC_{Sr})	0.1	8.8	3.1		5.9	0.4	55.8	7.1	1.9	168.3	3.4	14.0	268.9
14.1 Bought (ICb)	0.1	0.7	1.0		5.9	0.4	21.2	7.1	1.9	146.9	3.4		188.7
14.2 Own (ICo)							22.9			21.5		14.0	58.4
14.3 Environmental work in progress used (WPeu)		8.1	2.1				11.6						21.8
15. Revised labor cost (LCr)	0.2	8.1	3.2		5.1	1.2	19.9	5.6	10.1	44.0	3.9		101.4
15.1 Employee (LCe)	0.2	8.1	2.0		5.1	1.2	19.6	5.6	10.0	42.6	3.9		98.2
15.2 Self-employed (LCser)			1.2				0.3		0.1	1.4			3.1
16. Consumption of manu. fixed capital (CFCm)	0.1	0.5	0.2		2.6	0.1	7.7	4.2	13.8	14.8	2.6		46.6
17. Revised net operating margin ($NOM_{bp,Sr}$)	-0.2	5.8	3.6		14.6	-0.1	-24.0	-6.8	-5.5	-63.2	-5.2		-81.1
17.1 Manufactured net operating margin ($NOMm_{bp,S}$)	-0.4	-3.9	3.2		-10.6	-0.1	-53.4	-6.8	-5.5	-63.2	-5.2		-145.9
17.2 Environmental net operating margin ($NOMe_{Sr}$)	0.2	9.7	0.4		25.2		29.4						64.8
18. Revised net value added ($NVAr_{bp,Sr}$)	0.0	13.8	6.9		19.7	1.1	-4.1	-1.2	4.6	-19.2	-1.3		20.3
19. Revised gross value added ($GVAr_{bp,Sr}$)	0.1	14.3	7.1		22.3	1.2	3.6	3.0	18.4	-4.4	1.3		66.9
20. Revised gross operating margin ($GOMr_{bp,Sr}$)	-0.1	6.3	3.9		17.2	-0.1	-16.3	-2.6	8.3	-48.4	-2.6		-34.5
21 Revised environmental income ($EI_{bp,Sr}$)	1.6	65.8	9.1	0.0	22.2		29.4					-187.7	-59.6
21.1 Ecosystem services ($ES_{bp,S}$)		8.1	2.1		25.2		29.7						65.0
21.2 WPeu adjusted to change of environmental net worth (CNWead)	1.6	57.7	6.9	0.0	-3.0		-0.3					-187.7	-124.6

Table S6. Holm oak *dehesas* case studies farms revised standard accounts summary of production, income generation, accumulation and capital in Andalusia, Spain (2010: €/ha)

Class	Farmer	Fire services	Recreation	Mushrooms	Carbon	Landscape	Biodiversity	Water	Government	*Dehesas*
	13	14	15	16	17	18	19	20	21=∑14-20	22=13+21
1. Total product consumption (TPc_{bp})	360.8	31.5	7.1	13.3		77.1	4.8	69.6	203.3	564.1
1.1 Intermediate product (IP_{bp})	96.1	31.5							31.5	127.5
1.1.1 Raw materials (IRM)	44.4									44.4
1.1.1.1 Grass and browse (IRMgb)	12.6									12.6
1.1.1.2. Acorn (IRMa)	13.7									13.7
1.1.1.3 Recreational standing game hunted (IRMh)	18.0									18.0
1.1.2 Services (ISS)	51.7	31.5							31.5	83.1
1.1.2.1 Commercial (ISSc)	15.6	31.5							31.5	47.1
1.1.2.2 Compensated (ISSncc)	36.0									36.0
1.2 Final product consumed (FPc_{pp})	264.7		7.1	13.3		77.1	4.8	69.6	171.8	436.5
2. Revised ordinary intermediate consumption (ICo_{Sr})	267.8	10.2	2.3	0.1		69.9	1.5		84.0	351.7
2.1 Manufactured bought (ICmob)	187.5	10.2	1.4	0.1		1.8	1.5		14.9	202.4
2.2 Manufactured own (ICmo)	58.4		1.0			68.1			69.1	127.5
2.3 Environmental work in progress used (WPeu)	21.8									21.8
3. Revised ordinary labor cost (LCor)	99.3	20.2	3.6	0.1		5.1	2.9		31.8	131.1
3.1 Employee (LCeor)	96.2	20.2	3.6	0.1		5.1	2.9		31.8	128.0
3.2 Self-employed (LCseor)	3.1									3.1
4. Ordinary consumption of manu. fixed capital (CFCmo)	46.6	1.0	1.2	0.0		2.1	0.4		4.8	51.4
5. Ordinary net operating margin ($NOMo_{bp,S}$)	-52.9	0.0		13.1				69.6	82.7	29.8
5.1 Manufactured net operating margin ($NOMmo_{bp,S}$)	-96.1	0.0		0.5		0.0	0.0		0.5	-95.6
5.2 Environmental net operating margin ($NOMeo_S$)	43.2			12.6				69.6	82.2	125.4
6. Revised ordinary net value added ($NVAo_{bp,Sr}$)	46.4	20.2	3.6	13.2		5.1	2.9	69.6	114.5	160.9
7. Revised gross capital formation (GCF_{Sr})	-24.9	2.7	0.6	0.1		0.8	1.1		5.2	-19.7
7.1 Manufactured (GCFm)	-46.5	2.7	0.6	0.1		0.8	1.1		5.2	-41.3
7.2 Natural growth (NG)	21.6									21.6
8. Investment intermediate consumption (ICmib)	1.2	0.9	0.2	0.0		0.2	0.4		1.7	2.8
9. Investment labor cost (LCi)	2.1	1.8	0.4	0.1		0.6	0.7		3.6	5.6
10. Investment consumption of manu. fixed capital (CFCmi)										
11. Revised investment net operating margin ($NOMi_{Sr}$)	-28.2	0.0	0.0	0.0		0.0			0.0	-28.2
11.1 Manufactured net operating margin (NOMmi)	-49.8	0.0	0.0	0.0		0.0			0.0	-49.8
11.2 Environmental net operating margin ($NOMei_{Sr}$)	21.6									21.6
12. Revised investment net value added ($NVAmi_{Sr}$)	-26.1	1.8	0.4	0.1		0.6	0.7		3.6	-22.6
13. Revised total product ($TP_{bp,Sr}$)	335.8	34.1	7.7	13.4		77.9	5.8	69.6	208.5	544.4
14. Revised intermediate consumption (IC_{Sr})	268.9	11.1	2.5	0.1		70.1	1.8		85.6	354.6
14.1 Bought (ICb)	188.7	11.1	1.5	0.1		2.0	1.8		16.5	205.2
14.2 Own (ICo)	58.4		1.0			68.1			69.1	127.5
14.3 Environmental work in progress used (WPeu)	21.8									21.8
15. Revised labor cost (LCr)	101.4	22.0	4.0	0.1		5.7	3.6		35.4	136.7
15.1 Employee (LCe)	98.2	22.0	4.0	0.1		5.7	3.6		35.4	133.6
15.2 Self-employed (LCser)	3.1									3.1
16. Consumption of manu. fixed capital (CFCm)	46.6	1.0	1.2	0.0		2.1	0.4		4.8	51.4
17. Revised net operating margin ($NOM_{bp,Sr}$)	-81.1	0.0	0.0	13.1		0.0	0.0	69.6	82.7	1.6
17.1 Manufactured net operating margin ($NOMm_{bp,S}$)	-145.9	0.0	0.0	0.5		0.0	0.0		0.5	-145.3
17.2 Environmental net operating margin ($NOMe_{Sr}$)	64.8			12.6				69.6	82.2	147.0
18. Revised net value added ($NVAr_{bp,Sr}$)	20.3	22.0	4.0	13.3		5.7	3.6	69.6	118.1	138.4
19. Revised gross value added ($GVAr_{bp,Sr}$)	66.9	23.0	5.2	13.3		7.8	4.0	69.6	122.9	189.8
20. Revised gross operating margin ($GOMr_{bp,Sr}$)	-34.5	1.0	1.2	13.1		2.1	0.4	69.6	87.5	53.0
21 Revised environmental income ($EI_{bp,Sr}$)	-59.6			12.6				69.6	82.2	22.6
21.1 Ecosystem services ($ES_{bp,S}$)	65.0			12.6				69.6	82.2	147.2
21.2 WPeu adjusted to change of environmental net worth (CNWead)	-124.6									-124.6

Table S7. Holm oak *dehesas* cases studies extended capital account: work in progress and fixed capital in Andalusia, Spain (2010: €/ha).

Class	1. Opening capital	2. Capital entries				3. Capital withdrawals						4. Revaluation	5. Closing capital
		2.1 Bought	2.2 Own	2.3 Others	2.4 Total	3.1 Used	3.2 Sales	3.2 Destructions	3.3.Recla-sssifications	3.4 Others	3.5 Total		
	(Co)	(Ceb)	(Ceo)	(Ceot)	(Ce)	(Cwu)	(Cws)	(Cwd)	(Cwrc)	(Cwo)	(Cw)	(Cr)	(Cc)
1. Capital (C=WP+FC)	10,657.7	38.4	164.3	68.3	271.0	223.4	8.3	8.9	57.8	29.1	327.5	-175.2	10,426.1
2. Work in progress (WP)	418.8	24.3	119.3	14.9	158.5	223.4			9.7	3.1	236.2	21.3	362.4
Timber (WPt)	10.2		0.2		0.2				0.2		0.2	0.9	11.1
Cork (WPc)	132.9		9.7		9.7	8.1			9.1		17.2	16.7	142.1
Firewood (WPf)	38.4		0.4		0.4	2.1			0.4		2.5	3.7	40.0
Non breeding livestock (WPnbl)	200.9	23.8	96.1	13.0	132.8	200.9					200.9	0.0	132.8
Hunting (WPh)	35.7	0.5	12.3	1.9	14.7	11.6				3.1	14.7	0.0	35.7
Agriculture (WPa)	0.7		0.7		0.7	0.7					0.7		0.7
3. Fixed capital (FC)	10,239.0	14.1	45.0	53.4	112.5		8.3	8.9	48.1	26.0	91.3	-196.5	10,063.7
3.1 Land (FCl)	7,912.0			49.5	49.5				48.1	19.0	67.1	-171.7	7,722.7
3.1.1 Commercial (FCco)	1,372.6											1.6	1,374.2
Timber (FClt)	25.3											0.8	26.1
Cork (FClc)	31.8											1.0	32.7
Firewood (FClf)	3.4											0.1	3.5
Nuts (FCln)	0.3											0.0	0.3
Grass and browse(FClg)	857.7												857.7
Acorns (FCla)	14.0											-0.2	13.8
Hunting (FClh)	385.1												385.1
Agriculture(FClag)	55.1												55.1
3.1.2 Environmental (FCle)	6,539.4			49.5	49.5				48.1	19.0	67.1	-173.3	6,348.5
Amenity (FClea)	3,051.7											-187.7	2,864.0
Recreation (FCler)	638.2												638.2
Mushrooms (FClem)	442.9												442.9
Carbon (FClec)	356.0			49.5	49.5				48.1	19.0	67.1	14.4	352.8
Landscape (FClel)	438.1												438.1
Biodiversity (FCleb)	169.3												169.3
Water (FClew)	1,443.2												1,443.2
3.2 Biological resources (FCbr)	1,087.6	5.0	37.2	3.9	46.1		8.3	8.1		6.6	23.0	50.2	1,160.8
Timber (FCbrt)	0.0												0.0
Cork (FCbrc)	716.2											47.6	763.8
Firewood (FCbrf)	123.6											5.2	128.9
Nuts (FCbrn)	0.2											0.0	0.2
Acorns (FCbra)	52.0											-2.6	49.4
Breeding livestock (FCbrb)	186.6	4.8	35.5	2.7	43.0		8.3	8.1		3.3	19.7	-0.2	209.7
Hunting (FCbrh)	8.9	0.2	1.7	1.2	3.1					3.3	3.3	0.2	8.9
3.3 Plantations (FCp)	6.1											-0.1	6.1
3.4 Infrastructure (FCco)	1,103.4		7.8		7.8							-56.8	1,054.4
3.5 Equipments (FCe)	126.0	9.1			9.1			0.9		0.4	1.3	-18.8	115.1
3.9 Others (FCo)	3.9											0.7	4.6

Table S8. Holm oak *dehesas* case studies extended capital account: environmental asset and manufactured in Andalusia, Spain (2010: €/ha).

Class	1.	2. Capital entry				3. Capital withdrawal						4.	5.
	Opening capital	2.1 Bought	2.2 Own	2.3 Other	2.4 Total	3.1 Used	3.2 Sales	3.2 Destruc-tions	3.3. Recla-sification	3.4 Other	3.5 Total	Capital reva-luation	Closing capital
	(Co)	(Ceb)	(Ceoo)	(Ceot)	(Ce)	(Cwu)	(Cws)	(Cwd)	(Cwrc)	(Cwot)	(Cw)	(Cr)	(Cc)
1. Environmental asset (EA)	8,975.0	0.7	24.3	52.6	77.6	21.8			57.8	25.4	105.0	-100.0	8,847.6
1.1 Farmer	5,487.3	0.7	24.3	3.1	28.1	21.8			9.7	6.4	38.0	-114.4	5,363.1
1.1.1 Timber	35.5		0.2		0.2				0.2		0.2	1.6	37.2
1.1.2 Cork	880.9		9.7		9.7	8.1			9.1		17.2	65.3	938.6
1.1.3 Firewood	165.4		0.4		0.4	2.1			0.4		2.5	9.1	172.4
1.1.4 Nuts	0.5											0.0	0.5
1.1.5 Grazing	923.7											-2.9	920.8
1.1.6 Hunting	429.7	0.7	14.0	3.1	17.8	11.6				6.4	18.0	0.2	429.7
1.1.7 Amenity	3,051.7											-187.7	2,864.0
1.2 Government	3,487.7			49.5	49.5				48.1	19.0	67.1	14.4	3,484.5
1.2.1 Recreation	638.2												638.2
1.1.2 Mushrooms	442.9												442.9
1.1.3 Carbon	356.0			49.5	49.5				48.1	19.0	67.1	14.4	352.8
1.1.4 Landscape	438.1												438.1
1.1.5 Biodiversity	169.3												169.3
1.1.6 Water	1,443.2												1,443.2
2. Manufactured (FCm)	1,682.7	37.7	140.0	15.7	193.4	201.5		8.9		3.7	222.5	-75.2	1,578.4
2.1 Farmer	1,557.4	37.7	134.5	15.7	187.9	201.5		8.9		3.7	222.5	-71.3	1,451.5
2.1.1 Plantations	6.1											-0.1	6.1
2.1.2 Constructions	1,023.9		2.3		2.3							-52.0	974.2
2.1.3 Equipments	84.1	9.1			9.1			0.9		0.4	1.3	-19.0	73.0
2.1.4 Livestock	387.5	28.6	131.5	15.7	175.8	200.9		8.1		3.3	220.6	-0.2	342.5
2.1.5 Agriculture	55.8		0.7		0.7	0.7					0.7	0.0	55.8
2.2 Government	125.3		5.5		5.5					0.0	0.0	-3.9	126.9
2.1.1 Plantations													
2.1.2 Constructions	79.5		5.5		5.5							-4.8	80.2
2.1.3 Equipments	41.9									0.0	0.0	0.2	42.1
2.1.4 Others	3.9											0.7	4.6
Total (C)	10,657.7	38.4	164.3	68.3	271.0	223.4		8.9	57.8	29.1	327.5	-175.2	10,426.1

Table S9. Holm oak *dehesas* case studies extended capital account: produced and expected work in progress in Andalusia, Spain (2010: €/ha).

Class	1. Opening capital	2. Capital entries				3. Capital withdrawals						4. Reva-luation	5. Closing capital
		2.1 Bought	2.2 Own	2.3 Others	2.4 Total	3.1 Used	3.2 Sales	3.2 Destructions	3.3.Recla-sifications	3.4 Others	3.5 Total		
	(Co)	(Ceb)	(Ceo)	(Ceot)	(Ce)	(Cwu)	(Cws)	(Cwd)	(Cwrc)	(Cwo)	(Cw)	(Cr)	(Cc)
1. Work in progress (WP)	418.8	24.3	119.3	14.9	158.5	223.4			9.7	3.1	236.2	21.3	362.4
Timber (WPt)	10.2		0.2		0.2				0.2		0.2	0.9	11.1
Cork (WPc)	132.9		9.7		9.7	8.1			9.1		17.2	16.7	142.1
Firewood (WPf)	38.4		0.4		0.4	2.1			0.4		2.5	3.7	40.0
Non breeding livestock (WPnbl)	200.9	23.8	96.1	13.0	132.8	200.9					200.9	0.0	132.8
Hunting (WPh)	35.7	0.5	12.3	1.9	14.7	11.6				3.1	14.7	0.0	35.7
Agriculture (WPa)	0.7		0.7		0.7	0.7					0.7		0.7
1.1 Produced (WPp)	362.7	24.3	119.3	14.9	157.8	223.4				3.1	226.5	9.9	303.9
Timber (WPpt)	5.2		0.2		0.2							0.2	5.5
Cork (WPpc)	93.5		9.7		9.7	8.1					8.1	6.2	101.4
Firewood (WPpf)	26.8		0.4		0.4	2.1					2.1	2.8	27.9
Non breeding livestock (WPpnbl)	200.9	23.8	96.1	13.0	132.8	200.9					200.9	0.0	132.8
Hunting (WPph)	35.7	0.5	12.3	1.9	14.7	11.6				3.1	14.7	0.0	35.7
Agriculture (WPpa)	0.7		0.7			0.7					0.7	0.7	0.7
1.2 Expected (WPe)	56.0								9.7		9.7	12.1	58.5
Timber (WPet)	5.1								0.2		0.2	0.7	5.6
Cork (WPec)	39.4								9.1		9.1	10.5	40.7
Firewood (WPef)	11.6								0.4		0.4	0.9	12.2

Table S10. Holm oak *dehesas* case studies extended flow and stocks prices in Andalusia, Spain (2010: €/unit)

Class	Unity	Environmental asset price	Environmental Price of Harvest	Stumpage Price of Harvest	Farm-Road Price of Harvest
1. Timber	m^3	0.47			
2. Cork	t	240.07	801.43	801.43	1,339.71
3. Firewood	m^3	0.78	12.05	12.05	55.37
4. Grazing fodder	100 FU		6.74	7.06	
5. Supplements fodder	FU				0.24
6. Hunting captures	he	37.04	100.00	100.00	168.97
7. Livestock stock					
Females					
Bovine	he				1,057.01
Ovine	he				57.63
Caprine	he				38.65
Birth					
Bovine	he				274.57
Ovine	he				43.84
Caprine	he				32.20
Sales					
Bovine	he				1,044.51
Ovine	he				44.85
Caprine	he				33.43
Porcine					19.76
Ageing (breeders)					
Bovine	he				418.81
Ovine	he				26.65
Caprine	he				13.19
8. Residential	m^2				29.43
9. Recreation	vi		10.07		15.29
10. Mushrooms	kg		5.30		5.60
11. Carbon	t CO_2		13.73		13.73
12. Economic water	m^3		0.12		0.12

Abbreviations. m^3: cubic meters; t: ton; kg: kilograms; FU: forage unit; he: head; m^2: square meters; vi: visits; t CO_2: tons of carbon dioxide.

Table S11. Holm oak *dehesas* case studies extended production account at social prices in Andalusia, Spain (2010: €/ha)

Class	Timber	Cork	Fire-wood	Nuts	Grazing	Conserv. forestry	Hunting	Com. recreation	Residen-tial	Live-stock	Agri-culture	Amenity	Farmer	Fire services	Recrea-tion	Mush-rooms	Carbon	Land-scape	Bio-diversity	Water	Govern-ment	*Dehesas*
	1	2	3	4	5	6	7	8	9	10	11	12	13=∑1-12	14	15	16	17	18	19	20	21=∑14-20	22=13+21
1. Total product (TP)	0.6	27.6	11.9		40.9	2.1	116.9	10.1	20.4	459.8	4.9	295.2	990.3	34.1	24.3	13.4	49.5	91.1	11.0	81.9	305.3	1,295.6
1.1 Intermediate product (IP)	0.4	4.4	1.6		40.3	2.1	75.6		14.0	111.7	1.1		251.4	31.5							31.5	282.8
1.1.1 Raw materials (IRM)					26.4		18.0				0.3		44.7									44.7
1.1.1.1 Grazing others (IRMg)					12.6						0.0		12.7									12.7
1.1.1.2 Grazing acorn (IRMa)					13.7								13.7									13.7
1.1.1.3 Recreational standing game hunted (IRMh)							18.0						18.0									18.0
1.1.1.4 Others (IRMot)											0.3		0.3									0.3
1.1.2 Services (ISS)	0.4	4.4	1.6		14.0	2.1	57.5		14.0	111.7	0.8		206.7	31.5							31.5	238.2
1.1.2.1 Commercial (ISSc)						1.6			14.0				15.6	31.5							31.5	47.1
1.1.2.2 Non-commercial (ISSnc)	0.4	4.4	1.6		14.0	0.5	57.5			111.7	0.8		191.1									191.1
1.2.2.2.1 Compensated (ISSncc)					1.3					33.9	0.8		36.0									36.0
1.2.2.2.2 Auto-consumed (ISSnca)	0.4	4.4	1.6		12.7	0.5	57.5			77.8			155.0									155.0
1.2 Final product (FP)	0.2	23.2	10.2		0.6		41.3	10.1	6.3	348.0	3.8	295.2	738.9	2.7	24.3	13.4	49.5	91.1	11.0	81.9	273.8	1,012.8
1.2.1 Final product cosumed (FPc)		13.5	9.8		0.6		29.7	10.1	4.0	179.8	3.2	295.2	545.8		23.7	13.3	49.5	90.2	9.9	81.9	268.6	814.4
1.2.1.1 Sales (FPs)		13.5	9.2		0.6		27.3	10.1		177.3	3.1		241.1									241.1
1.2.1.2 Autoconsumption (FPa)			0.6				2.4			2.5	0.0	295.2	300.7									300.7
1.2.1.3 Other final product (FPo)									4.0				4.0									4.0
1.2.1.4 Public goods and services (PGS)															23.7	13.3	49.5	90.2	9.9	81.9	268.6	268.6
1.2.2 Gross capital formation (GCF)	0.2	9.7	0.4				11.6		2.3	168.3	0.7		193.1	2.7	0.6	0.1		0.8	1.1		5.2	198.3
1.2.2.1 Gross capital formation manu. (GCFm)							0.3		2.3	168.3	0.7		171.6	2.7	0.6	0.1		0.8	1.1		5.2	176.8
1.2.2.1.1 Gross fixed capital formation manu. (GFCFm)							0.3		2.3	35.5			38.1	2.7	0.6	0.1		0.8	1.1		5.2	43.3
1.2.2.1.1.1 Plantations (GFCFmp)													0.0									0.0
1.2.2.1.1.2 Construction (GFCFmc)							0.3		2.3				2.6	2.7	0.6	0.1		0.8	1.1		5.2	7.8
1.2.2.1.1.3 Breeding and draught livestock (GFCFmb)										35.5			35.5									35.5
1.2.2.1.2 Gross in work progress manu.. (GWPFm)										132.8	0.7		133.5									133.5
1.2.2.1.2.1 Non-breeding livestock (GWPFeh)										132.8			132.8									132.8
1.2.2.1.2.2 Agricultural crops (GFCFeh)											0.7		0.7									0.7
1.2.2.2 Natural growth (NG)	0.2	9.7	0.4				11.3						21.6									21.6
1.2.2.2.1 Environmental gross fixed capital (GFCFe)							1.7						1.7									1.7
1.2.2.2.1.1 Born female game breeders (GFCFeh)							1.7						1.7									1.7
1.2.2.2.2 Environmental gross fixed capital (GWPFe)	0.2	9.7	0.4				9.6						19.9									19.9
1.2.2.2.2.1Woody gross natural growth (GWPFew)	0.2	9.7	0.4										10.3									10.3
1.2.2.2.2.2Born non-breeding game (GFCFeh)							9.6						9.6									9.6
2. Total cost (TC)	0.4	17.4	6.6		13.7	1.7	83.4	16.9	25.8	428.0	9.8	169.1	772.8	34.1	7.7	0.3	19.0	77.9	5.8		144.8	917.6
2.1 Intermediate consumption (IC)	0.1	8.8	3.1		5.9	0.4	55.8	7.1	1.9	369.2	3.4	169.1	624.8	11.1	2.5	0.1		70.1	1.8		85.6	710.5
2.1.1 Raw materials (RM)	0.0	0.3	0.7		1.9	0.2	30.6	3.2	0.6	146.6	1.4		185.5	0.0	0.1	0.0		0.1	0.0		0.2	185.7
2.1.1.1 Bought raw materials (RMb)	0.0	0.3	0.7		1.9	0.2	7.7	3.2	0.6	124.9	1.4		140.8	0.0	0.1	0.0		0.1	0.0		0.2	141.0
2.1.1.2 Own raw materials (RMo)							22.9			21.8			44.7									44.7
2.1.2 Services (SS)	0.1	0.4	0.3		4.0	0.3	13.5	3.9	1.4	21.7	1.3	169.1	216.0	11.1	2.5	0.1		70.1	1.8		85.4	301.4
2.1.2.1 Bought services (SSb)	0.1	0.4	0.3		4.0	0.3	13.5	3.9	1.4	21.7	1.3		46.9	11.1	1.5	0.1		1.9	1.8		16.3	63.2
2.1.2.2 Own services (SSo)												169.1	169.1		1.0			68.1			69.1	238.2
2.1.3 Environmental work in progress used (WPue)		8.1	2.1				11.6			200.9	0.7		223.4									223.4
2.1.3.1 Timber harvested (WPuet)																						
2.1.3.2 Cork stripping (WPuec)		8.1											8.1									8.1
2.1.3.3 Firewood pruning (WPuef)			2.1										2.1									2.1
2.1.3.4 Livestock opening stock and bought (WPumf)										200.9			200.9									200.9
2.1.3.5 Opening game standing captured (WPuef)							11.6						11.6									11.6
2.1.3.5 Agricultural crops used (WPuma)											0.7		0.7									0.7
2.2 Labor cost (LC)	0.2	8.1	3.2		5.1	1.2	19.9	5.6	10.1	44.0	3.9		101.4	22.0	4.0	0.1		5.7	3.6		35.4	136.7
2.2.1 Employee (LCe)	0.2	8.1	2.0		5.1	1.2	19.6	5.6	10.0	42.6	3.9		98.2	22.0	4.0	0.1		5.7	3.6		35.4	133.6
2.2.2 Self-employed (LCse)			1.2				0.3		0.1	1.4			3.1									3.1
2.3 Consumption of fixed capital (CFC)	0.1	0.5	0.2		2.6	0.1	7.7	4.2	13.8	14.8	2.6		46.6	1.0	1.2	0.0	19.0	2.1	0.4		23.8	70.4
2.3.1 Plantations (CFCp)		0.1											0.1									0.1
2.3.2 Constructions (CFCc)	0.0	0.2	0.1		2.3	0.1	4.5	3.4	13.7	9.3	1.2		34.8	0.8	1.0	0.0		0.7	0.1		2.7	37.4
2.3.3 Equipments (CFCeq)	0.1	0.3	0.2		0.3	0.0	3.2	0.8	0.0	5.5	1.4		11.8	0.2	0.0	0.0		0.0	0.0		0.3	12.1
2.3.4 External environmental (CFCe)																	19.0				19.0	19.0
2.3.9 Others (CFCo)							0.0						0.0		0.2	0.0		1.4	0.3		1.8	1.9
3. Net operating margin (NOM = TP - TC)	0.2	10.2	5.3		27.3	0.4	33.5	-6.8	-5.5	31.8	-4.9	126.1	217.5	0.0	16.7	13.1	30.5	13.1	5.1	81.9	160.5	378.0
4. Net value added (NVA = LC + NOM)	0.4	18.2	8.5		32.4	1.6	53.4	-1.2	4.6	75.8	-1.0	126.1	318.9	22.0	20.6	13.3	30.5	18.8	8.7	81.9	195.8	514.7
5. Ordinary total cost (TCo)	0.4	17.4	6.6		13.7	1.7	83.1	16.9	23.5	393.6	9.2	169.1	735.2	31.5	7.1	0.2		77.1	4.8		120.6	855.7
6. Investment total cost (TCi)							0.3		2.3	34.4	0.7		37.7	2.7	0.6	0.1	19.0	0.8	1.1		24.2	61.9

Table S12. Holm oak *dehesas* case studies extended accounts total product and net value added in Andalusia, Spain (2010: €/ha).

Class	Timber	Cork	Fire-wood	Nuts	Gra-zing	Cons. forestry	Hun-ting	Com. recreation	Residen-tial	Live-stock	Agri-culture	Amenity	Farmer	Fire services	Recrea-tion	Mush-rooms	Carbon	Land-scape	Bio-diversity	Water	Govern-ment	*Dehesas*
	1	2	3	4	5	6	7	8	9	10	11	12	13=∑1-12	14	15	16	17	18	19	20	21=∑14-20	22=13+21
1. Total product consumption (TPc_{sp})	0.4	17.9	11.5		40.9	2.1	105.3	10.1	18.1	291.5	4.3	295.2	797.2	31.5	23.7	13.3	49.5	90.2	9.9	81.9	300.0	1,097.3
1.1 Intermediate product (IP_{sp})	0.4	4.4	1.6		40.3	2.1	75.6		14.0	111.7	1.1		251.4	31.5							31.5	282.8
1.2 Final product consumption (FPc_{pp})		13.5	9.8		0.6		29.7	10.1	4.0	179.8	3.2	295.2	545.8		23.7	13.3	49.5	90.2	9.9	81.9	268.6	814.4
2. Intermediate consumption (ICo_{sp})	0.1	0.7	1.0		5.9	0.4	44.0	7.1	1.6	334.8	2.7	169.1	567.4	10.2	2.3	0.1		69.9	1.5		84.0	651.4
2.1 Bougth (ICmob)	0.1	0.7	1.0		5.9	0.4	21.1	7.1	1.6	146.6	2.7		187.2	10.2	1.4	0.1		1.8	1.5		14.9	202.1
2.2 Own ($ICmo_{sp}$)							22.9			21.8		169.1	213.7		1.0			68.1			69.1	282.8
2.3 Manufactured work in progress used (WPmuo)										166.4			166.4									166.4
3. Compensation of employees (LCo)	0.2	8.1	3.2		5.1	1.2	19.8	5.6	8.2	44.0	3.9		99.3	20.2	3.6	0.1		5.1	2.9		31.8	131.1
4. Consumption of fixed capital (CFCmo)	0.1	0.5	0.2		2.6	0.1	7.7	4.2	13.8	14.8	2.6		46.6	1.0	1.2	0.0		2.1	0.4		4.8	51.4
5. Manufactured net operating margin ($NOMmo_{sp}$)	0.0	0.5	4.9		2.1	0.4	4.1	-6.8	-5.5	-102.1	-4.9		-107.2	0.0	1.0	0.5		0.2	0.8		2.5	-104.7
6. Ecosystem services (ES_{sp})		8.1	2.1		25.2		29.7					126.1	191.1		15.6	12.6	49.5	13.0	4.3	81.9	176.9	368.1
6.1 Environmental work in progress used (WPeu)		8.1	2.1				11.6						21.8									21.8
6.2 Environmental net operating margin (NOMeo)					25.2		18.0					126.1	169.3		15.6	12.6	49.5	13.0	4.3	81.9	176.9	346.2
7. Net value added ($NVAo_{sp}$) (TPc_{sp}–ICo_{sp}-WPeu-CFC)	0.2	8.6	8.1		32.4	1.6	41.9	-1.2	2.7	-58.1	-1.0	126.1	161.4	20.2	20.2	13.2	49.5	18.2	8.0	81.9	211.3	372.7
8. Gross capital formation (GCF)	0.2	9.7	0.4				11.6		2.3	168.3	0.7		193.1	2.7	0.6	0.1		0.8	1.1		5.2	198.3
8.1 Manufactured (GCFm)							0.3		2.3	168.3	0.7		171.5	2.7	0.6	0.1		0.8	1.1		5.2	176.8
8.2 Natural growth (NG)	0.2	9.7	0.4				11.3						21.6									21.6
9. Manufactured intermediate consumption (ICmi)							0.1		0.4	34.4	0.7		35.6	0.9	0.2	0.0		0.2	0.4		1.7	37.3
9.1 Bougth (ICmib)							0.1		0.4		0.0		0.5	0.9	0.2	0.0		0.2	0.4		1.7	2.2
9.2 Work in progress used (WPmui)										34.4	0.7		35.1									35.1
10. Compensation of employees (LCi)							0.1		1.9		0.0		2.1	1.8	0.4	0.1		0.6	0.7		3.6	5.6
11. Consumption of fixed capital (CFCi)																	19.0				19.0	19.0
11.1 Consumption of fixed manufactured capital (CFCmi)																						
11.2 Consumption of fixed environmental asset (SSe)																	19.0				19.0	19.0
12. Net operating margin (NOMi)	0.2	9.7	0.4				11.3		0.0	133.8	0.0		155.4	0.0		0.0	-19.0	0.0			-19.0	136.4
12.1 Manufactured (NOMmi)									0.0	133.8	0.0		133.8	0.0		0.0		0.0			0.0	133.8
12.2 Environmental (NOMei)	0.2	9.7	0.4				11.3						21.6				-19.0				-19.0	2.6
12.2.1 Natural growth (NG)	0.2	9.7	0.4				11.3						21.6									21.6
12.2.2 Less carbon emission (SSe)																	19.0				19.0	19.0
13. Net value added (NVAi) (GCF-ICmi-CFCi)	0.2	9.7	0.4				11.5		1.9	133.8	0.0		157.5	1.8	0.4	0.1	-19.0	0.6	0.7		-15.4	142.0

Table S12 (cont). Holm oak *dehesas* case studies extended accounts total product an net value added in Andalusia, Spain (2010: €/ha).

Class	Timber	Cork	Fire-wood	Nuts	Gra-zing	Conserv. forestry	Hun-ting	Comm. recreation	Residen-tial	Live-stock	Agri-culture	Amenity	Farmer	Fire services	Recrea-tion	Mush-rooms	Carbon	Land-scape	Bio-diversity	Water	Govern-ment	*Dehesas*
	1	2	3	4	5	6	7	8	9	10	11	12	13=∑1-12	14	15	16	17	18	19	20	21=∑14-20	22=13+21
14. Total product consumption (TP_{sp})	0.6	27.6	11.9		40.9	2.1	116.9	10.1	20.4	459.8	4.9	295.2	990.3	34.1	24.3	13.4	49.5	91.1	11.0	81.9	305.3	1,295.6
14.1 Intermediate product (IP_{sp})	0.4	4.4	1.6		40.3	2.1	75.6		14.0	111.7	1.1		251.4	31.5							31.5	282.8
14.2 Final product (FP_{pp})	0.2	23.2	10.2		0.6		41.3	10.1	6.3	348.0	3.8	295.2	738.9	2.7	24.3	13.4	49.5	91.1	11.0	81.9	273.8	1,012.8
14.2.2 Final product consumption (FPc_{pp})		13.5	9.8		0.6		29.7	10.1	4.0	179.8	3.2	295.2	545.8		23.7	13.3	49.5	90.2	9.9	81.9	268.6	814.4
14.2.2 Gross capital formation (GCF)	0.2	9.7	0.4				11.6		2.3	168.3	0.7		193.1	2.7	0.6	0.1		0.8	1.1		5.2	198.3
14.2.2.1 Manufactured (GCFm)							0.3		2.3	168.3	0.7		171.5	2.7	0.6	0.1		0.8	1.1		5.2	176.8
14.2.2.2 Natural growth (NG)	0.2	9.7	0.4				11.3						21.6									21.6
15. Intermediate consumption (IC_{sp})	0.1	8.8	3.1		5.9	0.4	55.8	7.1	1.9	369.2	3.4	169.1	624.8	11.1	2.5	0.1		70.1	1.8		85.6	710.5
15.1 Manufactured intermediate consumption (ICm)	0.1	0.7	1.0		5.9	0.4	44.1	7.1	1.9	369.2	3.4	169.1	603.0	11.1	2.5	0.1		70.1	1.8		85.6	688.6
15.1.1 Bought (ICmb)	0.1	0.7	1.0		5.9	0.4	21.2	7.1	1.9	146.6	2.7		187.7	11.1	1.5	0.1		2.0	1.8		16.5	204.3
15.1.2 Own ($ICmo_{sp}$)							22.9			21.8		169.1	213.7		1.0			68.1			69.1	282.8
15.1.3 Manufactured work in progress used (WPmu)										200.9	0.7		201.5									201.5
15.2 Environmental intermediate consumption (ICe)		8.1	2.1				11.6						21.8									21.8
15.2.1 Environmental work in progress used (WPeu)		8.1	2.1				11.6						21.8									21.8
16. Consumption of fixed capital (CFC)	0.1	0.5	0.2		2.6	0.1	7.7	4.2	13.8	14.8	2.6		46.6	1.0	1.2	0.0	19.0	2.1	0.4		23.8	70.4
17. Net value added (NVA_{sp}) (TP_{sp}-IC_{sp}-CFC)	0.4	18.2	8.5		32.4	1.6	53.4	-1.2	4.6	75.8	-1.0	126.1	318.9	22.0	20.6	13.3	30.5	18.8	8.7	81.9	195.8	514.7
18. Compensation of employees (LC)	0.2	8.1	3.2		5.1	1.2	19.9	5.6	10.1	44.0	3.9		101.4	22.0	4.0	0.1		5.7	3.6		35.4	136.7
19. Net operating margin (NOM_{sp})	0.2	10.2	5.3		27.3	0.4	33.5	-6.8	-5.5	31.8	-4.9	126.1	217.5	0.0	16.7	13.1	30.5	13.1	5.1	81.9	160.5	378.0
19.1 Manufactured net operating margin ($NOMm_{sp}$)	0.0	0.5	4.9		2.1	0.4	4.1	-6.8	-5.5	31.8	-4.9		26.6	0.0	1.0	0.5		0.2	0.8		2.5	29.2
19.2 Environmental net operating margin (NOMe)	0.2	9.7	0.4		25.2		29.4					126.1	190.9		15.6	12.6	30.5	13.0	4.3	81.9	157.9	348.8

Table S13. Holm oak *dehesas* case studies farmer extended accounts summary of production, income generation, accumulation and capital in Andalusia, Spain (2010: €/ha).

Class	Timber	Cork	Firewood	Nuts	Grazing	Conserv. forestry	Hunting	Comm. recreation	Residential	Livestock	Agriculture	Amenity	Farmer
	1	2	3	4	5	6	7	8	9	10	11	12	13=∑1-12
1. Total product (TP_{sp})	0.6	27.6	11.9		40.9	2.1	116.9	10.1	20.4	459.8	4.9	295.2	990.3
2 Manufactured intermediate consumption (ICm_{sp})	0.1	0.7	1.0		5.9	0.4	44.1	7.1	1.9	369.2	3.4	169.1	603.0
2.1 Bought (ICb)	0.1	0.7	1.0		5.9	0.4	21.2	7.1	1.9	146.6	2.7		187.7
2.2 Own (ICo_{sp})							22.9			21.8		169.1	213.7
2.3 Manufactured work in progress used (WPmu)										200.9	0.7		201.5
3. Labor cost (LC)	0.2	8.1	3.2		5.1	1.2	19.9	5.6	10.1	44.0	3.9		101.4
4. Consumption of fixed capital (CFC)	0.1	0.5	0.2		2.6	0.1	7.7	4.2	13.8	14.8	2.6		46.6
5. Ordinary manufactured net operating margin ($NOMmo_{sp}$)	0.0	0.5	4.9		2.1	0.4	4.1	-6.8	-5.5	-102.1	-4.9		-107.2
6. Investment net operating margin (NOMi)	0.2	9.7	0.4				11.3		0.0	133.8	0.0		155.4
7. Ecosystem services (ES_{sp})		8.1	2.1		25.2		29.7					126.1	191.1
7.1 Environmental work in progress used (WPue)		8.1	2.1				11.6						21.8
7.2 Ordinary environmental net operating margin (NOMeo)					25.2		18.0					126.1	169.3
8. Net value added (NVA_{sp}) (TP_{sp} – ICm_{sp} - WPue CFC)	0.4	18.2	8.5		32.4	1.6	53.4	-1.2	4.6	75.8	-1.0	126.1	318.9
8.1 Compensation of employees (LC)	0.2	8.1	3.2		5.1	1.2	19.9	5.6	10.1	44.0	3.9		101.4
8.2 Net operating margin (NOM_{sp})	0.2	10.2	5.3		27.3	0.4	33.5	-6.8	-5.5	31.8	-4.9	126.1	217.5
8.2.1 Manufactured net operating margin ($NOMm_{sp}$)	0.0	0.5	4.9		2.1	0.4	4.1	-6.8	-5.5	31.8	-4.9		26.6
8.2.2 Environmental net operating margin (NOMe)	0.2	9.7	0.4		25.2		29.4					126.1	190.9
9. Capital gain (CG)	1.3	55.6	8.5	0.0	-5.4	-0.2	-10.4	-3.8	-26.0	-28.5	-3.3	-187.7	-199.9
9.1 Manufactured (CGm)	-0.1	-0.5	-0.2		-2.4	-0.2	-10.4	-3.8	-26.0	-28.5	-3.3		-75.5
9.2 Environmental (EAg)	1.4	56.1	8.7	0.0	-3.0		0.0					-187.7	-124.4
9.2.1 Environmental asset revaluation (EAr)	1.6	65.3	9.1	0.0	-2.9		0.2					-187.7	-114.4
9.2.2 Growth adjusted to environmental asset (EAad)	-0.2	-9.1	-0.4	0.0	-0.1		-0.2					0.0	-10.0
10. Total income (TI_{sp})	1.7	73.9	17.0	0.0	27.0	1.4	43.0	-5.0	-21.4	47.2	-4.3	-61.6	119.0
10.1 Compensation of employees (LC)	0.2	8.1	3.2		5.1	1.2	19.9	5.6	10.1	44.0	3.9		101.4
10. 2 Capital income (CI_{sp})	1.5	65.8	13.7	0.0	21.9	0.2	23.1	-10.6	-31.5	3.2	-8.2	-61.6	17.6
10.2.1 Manufactured capital income (CIm)	-0.1	0.0	4.7		-0.3	0.2	-6.3	-10.6	-31.5	3.2	-8.2		-48.9
10.2.2 Environmental income (EI_{sp})	1.6	65.8	9.1	0.0	22.2		29.4					-61.6	66.5
10.2.2.1 Ecosystem services (ES_{sp})		8.1	2.1		25.2		29.7					126.1	191.1
10.2.2.2 WPeu adjusted to CNWe (CNWead)	1.6	57.7	6.9	0.0	-3.0		-0.3					-187.7	-124.6
10.2.2.2.1 Change of environmental net worth (CNWe)	1.6	65.8	9.1	0.0	-3.0		11.3					-187.7	-102.8
10.2.2.2.2 Less WPeu		8.1	2.1				11.6						21.8
11. Change of environmental net worth (CNWe)	1.6	65.8	9.1	0.0	-3.0		11.3					-187.7	-102.8
11.1 Investment of environmental net operating margin (NOMei)	0.2	9.7	0.4				11.3						21.6
11.2 Environmental asset gain (EAg)	1.4	56.1	8.7	0.0	-3.0		0.0					-187.7	-124.4

Table S14. Holm oak *dehesas* case studies farms extended accounts summary of production, income generation, accumulation and capital in Andalusia, Spain (2010: €/ha).

Class	Farmer	Fire services	Recreation	Mushrooms	Carbon	Landscape	Biodiversity	Water	Government	*Dehesas*
	13	14	15	16	17	18	19	20	21=∑14-20	22=13+21
1. Total product (TP_{sp})	990.3	34.1	24.3	13.4	49.5	91.1	11.0	81.9	305.3	1,295.6
2 Manufactured intermediate consumption (ICm_{sp})	603.0	11.1	2.5	0.1		70.1	1.8		85.6	688.6
2.1 Bought (ICb)	187.7	11.1	1.5	0.1		2.0	1.8		16.5	204.3
2.2 Own (ICo_{sp})	213.7		1.0			68.1			69.1	282.8
2.3 Manufactured work in progress used (WPmu)	201.5									201.5
3. Labor cost (LC)	101.4	22.0	4.0	0.1		5.7	3.6		35.4	136.7
4. Consumption of fixed capital (CFC)	46.6	1.0	1.2	0.0	19.0	2.1	0.4		23.8	70.4
5. Ordinary manufactured net operating margin ($NOMmo_{sp}$)	-107.2	0.0	1.0	0.5		0.2	0.8		2.5	-104.7
6. Investment net operating margin (NOMi)	155.4	0.0		0.0	-19.0	0.0			-19.0	136.4
7. Ecosystem services (ES_{sp})	191.1		15.6	12.6	49.5	13.0	4.3	81.9	176.9	368.1
7.1 Environmental work in progress used (WPue)	21.8									21.8
7.2 Ordinary environmental net operating margin (NOMeo)	169.3		15.6	12.6	49.5	13.0	4.3	81.9	176.9	346.2
8. Net value added (NVA_{sp}) (TP_{sp} – ICm_{sp} - WPue CFC)	318.9	22.0	20.6	13.3	30.5	18.8	8.7	81.9	195.8	514.7
8.1 Compensation of employees (LC)	101.4	22.0	4.0	0.1		5.7	3.6		35.4	136.7
8.2 Net operating margin (NOM_{sp})	217.5	0.0	16.7	13.1	30.5	13.1	5.1	81.9	160.5	378.0
8.2.1 Manufactured net operating margin ($NOMm_{sp}$)	26.6	0.0	1.0	0.5		0.2	0.8		2.5	29.2
8.2.2 Environmental net operating margin (NOMe)	190.9		15.6	12.6	30.5	13.0	4.3	81.9	157.9	348.8
9. Capital gain (CG)	-199.9	-1.0	1.3	0.4	-33.7	0.9	2.0		-30.0	-229.8
9.1 Manufactured (CGm)	-75.5	-1.0	1.3	0.4		0.9	2.0		3.7	-71.8
9.2 Environmental (EAg)	-124.4				-33.7				-33.7	-158.1
9.2.1 Environmental asset revaluation (EAr)	-114.4				14.4				14.4	-100.0
9.2.2 Growth adjusted to environmental asset (EAad)	-10.0				-48.1				-48.1	-58.1
10. Total income (TI_{sp})	119.0	21.0	21.9	13.7	-3.2	19.7	10.8	81.9	165.9	284.8
10.1 Compensation of employees (LC)	101.4	22.0	4.0	0.1		5.7	3.6		35.4	136.7
10. 2 Capital income (CI_{sp})	17.6	-1.0	18.0	13.5	-3.2	14.1	7.2	81.9	130.5	148.1
10.2.1 Manufactured capital income (CIm)	-48.9	-1.0	2.3	1.0		1.1	2.8		6.2	-42.6
10.2.2 Environmental income (EI_{sp})	66.5		15.6	12.6	-3.2	13.0	4.3	81.9	124.2	190.8
10.2.2.1 Ecosystem services (ES_{sp})	191.1		15.6	12.6	49.5	13.0	4.3	81.9	176.9	368.1
10.2.2.2 WPeu adjusted to CNWe (CNWead)	-124.6				-52.7				-52.7	-177.3
10.2.2.2.1 Change of environmental net worth (CNWe)	-102.8				-52.7				-52.7	-155.5
10.2.2.2.2 Less WPeu	21.8									21.8
11. Change of environmental net worth (CNWe)	-102.8				-52.7				-52.7	-155.5
11.1 Investment of environmental net operating margin (NOMei)	21.6				-19.0				-19.0	2.6
11.2 Environmental asset gain (EAg)	-124.4				-33.7				-33.7	-158.1

Table S15. Holm oak d*ehesas* case studies farms extended accounts ecosystem services at social prices in Andalusia, Spain (2010: €/ha).

Class	Farmer	Government	*Dehesas*
1. Provisioning services	65.0	94.5	159.5
1.1 Timber	0.0		0.0
1.2 Cork	8.1		8.1
1.3 Firewood	2.1		2.1
1.4 Nuts			
1.5 Grazing	25.2		25.2
Grass and browse	11.4		11.4
Acorns	13.7		13.7
1.6 Hunting	29.7		29.7
1.7 Mushrooms		12.6	12.6
1.8 Water		81.9	81.9
1.9 Livestock			*n.a*$^{(*)}$
1.10 Agriculture			0.0
2. Regulating services		66.8	66.8
2.1 Carbon		49.5	49.5
2.2 Landscape		13.0	13.0
2.3 Biodiversity		4.3	4.3
2.4 Conservation forestry			*n.a*$^{(*)}$
2.5 Fire services			*n.a*$^{(*)}$
3. Cultural services	126.1	15.6	141.7
3.1 Private amenity	126.1		126.1
3.2 Public recreation		15.6	15.6
3.3 Commercial recreation			*n.d*$^{(**)}$
3.4 Residential			*n.d*$^{(**)}$
Total	191.1	176.9	368.1

na$^{(*)}$: not apply
nd$^{(**)}$: not data

Table S16. Holm oak *dehesas* case studies farmer extended and revised standard accounts measurements at producer, basic and social price of ecosystem services and incomes (2010: €/ha)

Class	Timber	Cork	Firewood	Nuts	Grazing	Conserv. forestry	Hunting	Comm. recreation	Residential	Livestock	Agriculture	Amenity	Farmer
	1	2	3	4	5	6	7	8	9	10	11	12	13=∑1-12
Agroforestry Accounting System (AAS)													
AAS *at social prices*													
Ecosystem services (ES_{sp})		8.1	2.1		25.2		29.7					126.1	191.1
Gross value added (GVA_{sp})	0.5	18.7	8.7		35.0	1.7	61.1	3.0	18.4	90.6	1.6	126.1	365.5
Gross operating margin (GOM_{sp})	0.3	10.7	5.5		29.9	0.5	41.2	-2.6	8.3	46.6	-2.3	126.1	264.1
Environmental income (EI_{sp})	1.6	65.8	9.1	0.0	22.2		29.4					-61.6	66.5
AAS *at basic prices*													
Ecosystem services (ES_{bp})		8.1	2.1		25.2		29.7					281.1	346.1
Gross value added (GVA_{bp})	0.1	14.3	7.1		22.3	1.2	3.6	3.0	18.4	12.8	1.6	281.1	365.5
Environmental income (EI_{bp})	1.6	65.8	9.1	0.0	22.2		29.4					93.4	221.5
AAS at *producer prices*													
Ecosystem services (ES_{pp})		8.1	2.1		25.2		29.7					281.1	346.1
Gross value added (GVA_{pp})	0.1	14.3	7.1		21.1	1.2	3.6	3.0	18.4	-21.2	0.8	281.1	329.4
Environmental income (EI_{pp})	1.6	65.8	9.1	0.0	22.2		29.4					93.4	221.5
System of National Accounts revised													
SNA at basic prices													
Ecosystem services (ES_{bp})		8.1	2.1		25.2		29.7						65.0
Gross value added (GVA_{bp})	0.1	14.3	7.1		22.3	1.2	3.6	3.0	18.4	-4.4	1.3		66.9
Gross operating margin (GOM_{bp})	-0.1	6.3	3.9		17.2	-0.1	-16.3	-2.6	8.3	-48.4	-2.6		-34.5
Environmental income (EI_{bp})	1.6	65.8	9.1	0.0	22.2		29.4					-187.7	-59.6
SNA at producer prices													
Ecosystem services (ES_{pp})		8.1	2.1		25.2		29.7						65.0
Gross value added (GVA_{pp})	0.1	14.3	7.1		21.1	1.2	3.6	3.0	18.4	-38.3	0.5		30.8
Environmental income (EI_{pp})	1.6	65.8	9.1	0.0	22.2		29.4					-187.7	-59.6

Abbreviations: subscript sp is social prices, subscript bp is basic prices and subscript pp is producer prices.

Table S17. Holm oak *dehesas* case studies farms extended and revised standard accounts measurements at producer, basic and social prices of ecosystem services and incomes (2010: €/ha)

Class	Farmer 13	Fire services 14	Recreation 15	Mushrooms 16	Carbon 17	Landscape 18	Biodiversity 19	Water 20	Government 21=∑14-20	*Dehesas* 22=13+21
Agroforestry Accounting System (AAS)										
AAS *at social prices*										
Ecosystem services (ES_{sp})	191.1		15.6	12.6	49.5	13.0	4.3	81.9	176.9	368.1
Gross value added (GVA_{sp})	365.5	23.0	21.8	13.3	49.5	20.9	9.2	81.9	219.6	585.1
Gross operating margin (GOM_{sp})	264.1	1.0	17.8	13.1	49.5	15.3	5.6	81.9	184.3	448.4
Environmental income (EI_{sp})	66.5		15.6	12.6	-3.2	13.0	4.3	81.9	124.2	190.8
AAS *at basic prices*										
Ecosystem services (ES_{bp})	346.1		15.6	12.6	49.5	13.0	4.3	81.9	176.9	523.1
Gross value added (GVA_{bp})	365.5	23.0	21.8	13.3	49.5	20.9	9.2	81.9	219.6	585.1
Environmental income (EI_{bp})	221.5		15.6	12.6	-3.2	13.0	4.3	81.9	124.2	345.8
AAS at *producer prices*										
Ecosystem services (ES_{pp})	346.1		15.6	12.6	49.5	49.0	4.3	81.9	213.0	559.1
Gross value added (GVA_{pp})	329.4	23.0	21.8	13.3	49.5	57.0	9.2	81.9	255.7	585.1
Environmental income (EI_{pp})	221.5		15.6	12.6	-3.2	49.0	4.3	81.9	160.3	381.8
System of National Accounts revised										
SNA at basic prices										
Ecosystem services (ES_{bp})	65.0			12.6				69.6	82.2	147.2
Gross value added (GVA_{bp})	66.9	23.0	5.2	13.3		7.8	4.0	69.6	122.9	189.8
Gross operating margin (GOM_{bp})	-34.5	1.0	1.2	13.1		2.1	0.4	69.6	87.5	53.0
Environmental income (EI_{bp})	-59.6			12.6				69.6	82.2	22.6
SNA at producer prices										
Ecosystem services (ES_{pp})	65.0			12.6				69.6	82.2	147.2
Gross value added (GVA_{pp})	30.8	23.0	5.2	13.3		7.8	4.0	69.6	122.9	153.7
Environmental income (EI_{pp})	-59.6			12.6				69.6	82.2	22.6

Abbreviations: subscript sp is social prices, subscript bp is basic prices and subscript pp is producer prices.

Table S18. Holm oak *dehesas* case studies farms extended accounts incomes and ecosystem services measured by individual farm in Andalusia, Spain (2010).

Class	Surface (ha)	Total income (TI)	Capital income (CI)	Net valued added (NVA)	Environmental income (EI)	Ecosystem services (ES)	Labor cost (LC)
Dehesa D1	179	474.8	406.6	790.8	441.9	618.0	68.2
Dehesa D2	740	444.3	218.1	691.7	300.9	423.9	226.2
Dehesa D3	2,010	190.5	97.5	395.6	63.3	285.6	93.0
Dehesa D4	1,260	-7.9	-109.9	322.5	-102.3	204.0	102.0
Dehesa D5	186	124.7	101.8	318.6	124.1	212.9	23.0
Dehesa D6	286	532.4	507.6	546.9	594.8	534.6	24.8
Dehesa D7	468	228.9	180.2	598.4	240.5	493.8	48.8
Dehesa D8	211	19.2	-27.2	283.0	-69.6	367.9	46.4
Dehesa D9	306	401.7	351.3	617.8	402.1	569.4	50.4
Dehesa D10	356	1,287.9	1,237.9	897.3	1,441.7	671.1	50.1
Dehesa D11	296	317.5	246.0	516.9	315.2	438.8	71.5
Dehesa D12	314	169.6	20.5	320.6	149.0	343.9	149.1
Dehesa D13	1,336	467.0	83.7	818.5	190.0	473.7	383.3
Dehesa D14	710	33.3	-64.0	223.6	-40.6	110.2	97.2
Dehesa D15	77	431.5	386.1	577.7	447.9	455.5	45.4
Dehesa D16	298	304.2	270.1	604.6	324.2	574.2	34.1
Total	9,032	284.9	148.1	514.7	190.8	368.1	136.7
Minimal	76.8	-7.9	-109.9	223.6	-102.3	110.2	23.0
Maximum	2,010.2	1,287.9	1,237.9	897.3	1,441.7	671.1	383.3
Standard deviation	534.2	308.0	319.6	206.1	363.6	159.9	92.9

References

Campos, P., Ovando, P., Mesa, B., Oviedo, J.L., 2016. Environmental income of grazing on privately-owned silvopastoral farms in Andalusia. J. Land. Degrad. Dev. Special issue. doi:10.1002/ldr.2529

Campos, P., Mesa, B., Álvarez, A., Castaño, F.M., Pulido, F., 2017. Testing Extended Accounts in Scheduled Conservation of Open Woodlands with Permanent Livestock Grazing: Dehesa de la Luz Estate Case Study, Arroyo de la Luz, Spain. Environments 4(4), 82, 1-38. doi:10.3390/environments4040082

Campos, P., Caparrós, A., Oviedo, J.L., Ovando, P., Álvarez-Farizo1, B., Díaz-Balteiro, L., Carranza, J., Beguería, S., Díaz, M., Herruzo, A.C., Martínez-Peña, F., Soliño, M., Álvarez, A., Martínez-Jáuregui, M., Pasalodos-Tato, M., de Frutos, P., Aldea, J., Almazán, E., Concepción, E.D., Mesa, B., Romero, C., Serrano-Notivoli, R., Fernández, C., Torres-Porras, J., Montero, G., 2019. Bridging the Gap Between National and Ecosystem Accounting Application in Andalusian Forests, Spain. Ecol. Econ. 157, 218-236. doi.org/10.1016/j.ecolecon.2018.11.017

Caparrós, A., Oviedo, J.L., Álvarez, A., Campos, P., 2017. Simulated exchange values and ecosystem accounting: Theory and application to recreation. Ecol. Econ. 139, 140–149. doi: 10.1016/j.ecolecon.2017.04.011

Edens, B., Hein, L., 2013. Towards a consistent approach for ecosystem accounting. Ecol. Econ. 90, 41-52. doi: 10.1016/j.ecolecon.2013.03.003

Herruzo, A.C., Martínez-Jauregui, M., Carranza, J., Campos, P., 2016. Commercial income and capital of hunting: an application to forest estates in Andalucía. For. Policy Econ. 69: 53-61. (2016). doi: 10.1016/j.forpol.2016.05.004

Ovando, P., Campos, P., Oviedo, J.L., Caparrós, A., 2016. Ecosystem accounting for measuring total income in private and public agroforestry farms. For. Policy Econ. 71, 43–51. doi: 10.1016/j.forpol.2016.06.031

Oviedo, J.L., Huntsinger, L., Campos, P., 2017. Contribution of amenities to landowner income: Case of Spanish and Californian hardwood rangeland Ecol. Manage. 70, 518–528. doi: 10.1016/j.rama.2017.02.002