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Measurement of the Threatened Biodiversity Existence Value Output: Application of the Refined System of Environmental-Economic Accounting in the *Pinus pinea* Forests of Andalusia, Spain

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Abstract: Are we able to determine the existence value output generated for society through the preservation of wild species threatened with extinction? In this article we defend the theory that the service of preserving threatened species with risk of extinction is an existence value output with a hidden transaction price if it can be established that there are consumer or state willingness to pay an additional tax above the government total cost to avoid an increase in one threatened species in relation to the number recorded at the opening of the accounting period. This output is estimated by adding the total cost and the additional consumer tax which the consumers state that they are willing to pay through a choice experiment survey. Our refined monetary System of Environmental-Economic Accounting (rSEEA) extends the existence value output concept and valuation principles recommended by the United Nations. In this paper, this rSEEA was applied to *Pinus pinea* forests in protected as well as non-protected areas of Andalusia, Spain in 2010. The results show that the net value added from protected areas is 40% higher than that from non-protected areas. It is incidental that the environmental benefits in both areas coincide.

Keywords: output; choice experiment; additional consumer tax; ecosystem service; net value added; operating benefit; produced benefit; environmental benefit

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1. Introduction

Mitigating the threat of extinction of wild species and the degradation/destruction of their natural habitats on the planet has been addressed by governments in many countries through public policies strictly regulating changes in land use and coastal areas as well as moving away from economic activities involving the extraction of plants and animals in national parks. Policies aimed at incentivising the development of economic activities in protected areas other than national parks are common. Regarding economic statistics, in the design of public policies for protected areas, governments do not provide the public service of environmental-economic accounts for protected and non-protected natural areas. The conventional System of National Accounts (SNAs) provides the gross domestic product (gross value added) of the commercial economic activities without uncovering the contribution of nature [1]. This limitation of the public statistics makes it difficult to determine the economic contribution of nature conservation policies to the gross value added at national/sub-national territory scale. Government policies on the preservation of wild species threatened with extinction (hereafter biodiversity) are aimed at mitigating and/or avoiding its irreversible loss and that of its habitats through regulating economic activities and prohibiting the commercial extraction of wild animals and woody products in national parks. Common to all types of protected area is the fact that the government regulations omit the implementation of ecosystem accounting. Since the Nagoya protocol came into force, the agendas of specialized government institutions have begun to include the debate on standardizing the regulations and implementation of monetary ecosystem accounting [2–5].

The tragedy of the accelerated irreversible loss of biodiversity due to the increase in the extraction of natural resources and changes in the use of land and aquatic areas may have been mitigated by protectionist regulations at global and national/sub-national scales, although the results are insufficient to stop the loss of wild species and their habitats on the planet [2,6]. Specialized institutions (e.g., United Nations Statistical Commission, Eurostat) and experts are constantly alerting governments on the urgency of avoiding/mitigating the effect of economic activities on the degradation and loss of biodiversity in natural areas, whether specifically designated as protected areas or not. New active investment policies are required for integrated management of biological and economic sustainability of territories at local, national, and global spatial scales. Regarding environmental management, it is considered that for active policies on biodiversity to be long-lasting, they must be based on the best scientific biophysical and economic knowledge available [7].

The biodiversity existence value output (hereinafter biodiversity output) refers only to the species preservation services at the transaction price stated by Andalusian passive consumers of these services. Thus, we do not measure the environmental benefits of the species incorporated in other outputs, such as for example, the recreational and cultural landscape. The simulated biodiversity output measured at the transaction price tends to be rejected by academic experts and national accountants [5,8]. Technical reports on the economic activities in protected areas do not directly address the contribution of biodiversity, but rather, show the output and/or values added of other conventional economic activities incorporated in the SNA which use the natural and environmental resources of the protected areas for free [9–11].

The exception to this rejection of the biodiversity output among scientific publications is that which deals with the estimation of net value added at regional level (with no distinction between protected and non-protected areas) of Andalusian forests as a whole [12] and cork and holm oak woodlands [13,14]. Studies estimating biodiversity outputs have also been carried out at the scale of publicly owned conifer forest farms located in protected areas of Andalusia, one focusing on forests of *Pinus nigra* Arn., *Pinus halepensis* Mill., *Pinus sylvestris* L. and *Pinus pinaster* Ait. [15] and another on *Pinus pinea* L. [16].

The objective of this research is to value the biodiversity output in protected and non-protected areas of Stone pine (*Pinus pinea*) forests (SPs) in Andalusia, Spain. The gross values added (GVA) and net values added (NVA) as well as the operating benefit (B) were divided into produced benefit (PB) and environmental benefit (EB). The latter is a term synonymous with ecosystem service (ES). The estimated number of threatened species and the economic results for the biodiversity of the SPs in protected and non-protected areas are compared.

The United Nations System of Environmental-Economic Accounting–Ecosystem Accounting (SEEA–EA) rejects the valuation of simulated transaction price of the biodiversity output [5,17]. This recommendation is not adopted in this article as we consider it to be inconsistent, bearing in mind the valuation methods and extension of the concept of economic output without market price as recommended in chapters 8–11 of the SEEA–EA (hereafter SEEA). Our refined SEEA (henceforth rSEEA) consists of incorporating the biodiversity benefit (B) at the simulated transaction price in the valuation of the biodiversity output. The biodiversity benefit is estimated using the choice experiment and simulated exchange value (SEV) methods which provide the valuation of the additional marginal willingness to pay of passive consumers.

In this article our rSEEA is applied in an area defined by the map tiles of the Spanish Forest Map in which the predominant canopy fraction corresponds to *Pinus pinea* (SP), an area totalling 243,559 hectares of which 57% falls within protected areas and the remaining 43% in non-protected areas [18].

The biodiversity output (O) is estimated by aggregating the values of the additional consumer tax (ACT) marginal willingness to pay and the total cost (TC) of the biodiversity, representing the output of preserving the 104 wild biological species threatened with risk of extinction which are present in the protected and non-protected areas of the Stone pine forests (SPs) of Andalusia.

In the following sections of the article, we describe the concepts, methods, and results which explain the consistency of the results in terms of the economic rationale of the consumers and the government ecosystem trustee in the SPs of Andalusia.

2. Concepts and Valuation Methods for Biodiversity Output Applied to the *Pinus pinea* Forests of Andalusia

2.1. Concept of Transaction Price of Biodiversity Output

This sub-section sustains the theory that biodiversity threatened with extinction can generate a demand function based on the preferences of passive consumers who pay or are willing to pay to avoid/mitigate the risk of extinction.

This research concept of biodiversity output refers solely to species threatened with risk of extinction [19] (pp. 41–45). The output of the biodiversity preservation service (the same threatened species may be contributing to other economic products, e.g.,: public recreation services, self-consumption of private amenities by the owners) relates to the well-being perceived by the passive consumers in the period, associated with avoiding and/or mitigating the risk of losing a biological species in return for their marginal willingness to pay a simulated additional consumer tax (ACT) and the total cost (TC) [20] (Figure 1, p. 4).

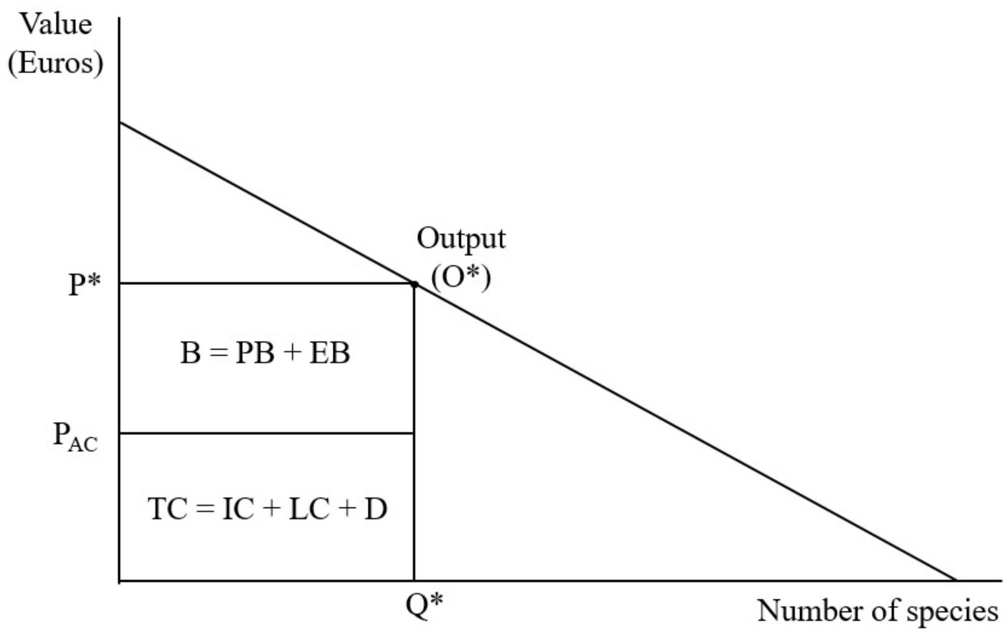

Figure 1. Simulated market equilibrium output for threatened biodiversity. Notes: P* is demand and supply simulated market equilibrium price; O* is the price of the output that corresponds to the total amount of threatened species (Q*); P_{AC} is government output average total cost; B is total operating benefit; PB is produced benefit; EB is environmental benefit; TC is total cost; IC is intermediate consumption; LC is labour cost; D is depreciation of manufactured (produced) fixed capital; and Q* is total number of threatened species.

The argument that the biodiversity output (O) cannot be valued as there is no equivalent with which it can be compared with to reveal its transaction price is incorrect and stems from this value being confused with its intrinsic value [19] (p. 27), [5] (Para. 6.72, p. 137). Thus, the price of the biodiversity output is the relationship of the exchange decided by natural persons or institutions (in representation of natural persons) transferred reciprocally in the exchange in exclusive property rights over the biodiversity output and its consumption appropriated in return for real and/or simulated payment. The rationale behind why people can reveal/state a maximum price for the biodiversity demand is that in the future this species threatened with extinction can have a hitherto unknown use for humanity. A growing number of academics in social and natural sciences employ the term 'non-use' to refer to the passive uses of the option values among which is the biodiversity output; it is consistent to state the absence of a simulated transaction of something without human use. This is not the case of biodiversity as evidenced by the voluntary donations by people with the aim of preserving the threatened biodiversity of the planet [21]. This output of the threatened biodiversity is a passive consumption by people in addition to the passive output of the landscape conservation service (people's willingness to pay tax to avoid losses of non-threatened natural habitats) to which biodiversity contributes as a natural production factor of the cultural landscape.

The corollary of the above arguments is that the existence of a biodiversity demand function has the economic meaning of a transaction value when contrasted with the observed real or simulated acts of the passive consumers [20] (Figure 1, p. 4). The observed consumption is revealed in the voluntary contributions of the consumers to the economic units addressing the preservation of threatened biodiversity, the acceptance of public spending, and the additional payment towards the latter stated by the consumers in the surveys estimating the maximum marginal willingness to pay tax (e.g., choice experiment).

2.2. The Refined SEEA Output and Income Accounts for Threatened Biodiversity

The benefit of the threatened biodiversity at the scale of Andalusian forests is the same for all individual species, the forest area distribution of each of these individual species being where differences arise in this regard. The environmental benefit is obtained by subtracting the produced benefit from total benefit. The produced benefit is imputed according to a subjective real profitability rate of 3% of the government's public spending investment in the management of biodiversity for each type of forest at the scale of the micro-tiles of the Spanish Forest Map for Andalusia [18].

In countries with greater personal income levels the surveys gauging the opinion of the population reveal a general acceptance of current public spending on the preservation of habitats and wild species [22,23] (70% of Spaniards and 65% of Europeans consider that the destruction of natural habitats or the loss of animal or plant species is an "immediate and urgent" problem [22]). The government (acting as an ecosystem trustee) manages biodiversity by investing an operating total cost (TC). The biodiversity total cost in the rSEEA corresponds to the lower bound of the marginal willingness to pay tax revealed by the passive consumers. This assumption is based on the fact that it is the consumers who, through their votes, periodically endorse the programmes of environmental policies applied by the governments as part of their public spending actions in representation of the citizens (Figure 1). It is necessary to estimate the upper bound of the marginal willingness to pay tax of passive consumers regarding the biodiversity output (Figure 1, Table 1).

The standard System of National Accounts (SNAs) and SEEA estimated the threatened biodiversity output according to the total cost (TC) at purchase prices (Table 1). The condition of the biodiversity output as a public service without market price means that the SNA assumed a value of zero for the simulated benefit (B). In this research the inconsistency of the SNA of imputing a value of zero to the B implicitly embedded in the output (O*) is avoided by simulating its exchange value through stated preference methods recommended by the United Nations in the SEEA guidelines [5].

Table 1. Key economic variable and accounting identity application of the refined SEEA in this case study on the existence value of threatened biodiversity in *Pinus pinea* forests of Andalusia.

Class	Acronym	This Paper's rSEEA	United Nations SEEA [5]	Accounting Identity
Output	O	Service of preserving wild species threatened with risk of extinction. It is valued by summing additional consumer tax (ACT) and total cost (TC). ACT is measured by a choice experiment survey to Andalusian households. TC is measured by biodiversity production function accruing from Andalusian government unpublished sources.	Service of preserving wild species threatened with risk of extinction is hidden in the government general production account of the System of National Accounts (SNAs). It is valued at total cost (TC).	O_{rSEEA} = ACT + TC O_{rSEEA} = ACT + O_{SEEA} O_{SEEA} = TC
Intermediate consumption	IC	Purchases of raw materials (RM) and services (SS) used as inputs in the generation of the output (O) in the accounting period.	Purchases of raw materials (RM) and services (SS) used as inputs in the generation of the output (O) in the accounting period.	IC = RM + SS
Gross valued added	GVA	Value of the biodiversity output (O) less intermediate consumption (IC).	Value of the biodiversity total cost (TC) less intermediate consumption (IC).	$GVA_{rSEEA} = O_{rSEEA} - IC$ $GVA_{SEEA} = TC - IC$
Depreciation	D	Consumption due to the use and obsolescence of produced durable goods used in the generation of output in the accounting period. Depreciation is valued at its replacement price. The components of durable goods are buildings (BD) and equipment (ED).	It coincides with rSEEA.	D = BD + ED
Net value added	NVA	Remuneration of the production factors of labour cost (LC) and benefits (B) at social price.	Omits the benefits (B).	$NVA_{rSEEA} = GVA - D$ NVA_{rSEEA} = LC + B NVA_{SEEA} = LC
Labour cost	LC	Employee compensation.	Employee compensation.	

Table 1. *Cont.*

Class	Acronym	This Paper's rSEEA	United Nations SEEA [5]	Accounting Identity
Benefit	B	Simulated benefit is valued at additional consumer tax (ACT) transaction price for Stone pine forests (SP) which the adult population of Andalusia would be willing to pay via an annual payment to avoid a one-species variation in the number of threatened species at the close of the period compared with the number at the opening of the period. Benefit is divided into imputed competitive produced capital benefit (PB) and residual environmental benefit of durable ecosystem asset (EB).	Rejects the existence of simulated benefit at transaction price for the existence value of threatened biodiversity [5] (para. 6.72, p. 137).	$B_{rSEEA} = PB + EB$ $B_{rSEEA} = O_{rSEEA} - TC$
Total cost	TC	Produced production factors of intermediate consumption (IC), labour cost (LC) and depreciation of durable capital (D) of ordinary produced fixed capital (D) used up in the accounting period by the government (ecosystem trustee) in the provision of the output (O) of threatened biodiversity.	It coincides with rSEEA.	$TC = IC + LC + D$

The simulation of the upper bound of biodiversity output requires us to estimate the possible existence of a marginal willingness to pay additional tax (ACT) on top of the lower bound demand (TC) in return for avoiding/mitigating the future loss of species or an increase by one species in the number of species threatened with extinction at period closing.

In the *Pinus pinea* case study, the ACT of the biodiversity was firstly estimated (a mixed transaction value of area extent and biodiversity physical change values) together with the landscape conservation service using the choice experiment method and the transaction price of the ACT was determined using the simulated exchange value method [12] (Supplementary Texts S9 and S10). In accounting terms, the ACT corresponds, by definition, to the benefit (termed net operating surplus in the SNA and SEEA) given that the stated lower bound demand corresponds to the TC (Figure 1, Table 1).

In this article we used information obtained from the choice experiment survey carried out in the Andalusian forest areas (AFAs) in 2010 [12]. An intuitive definition of the choice experiment applied is that the consumers are presented with a choice of preservation through the payment of an annual "fee" of their choice over a period of 30 years to ensure that the output of biodiversity does not decline (the number of species threatened or lost does not increase), to guarantee that the current situation is maintained, they pay an "insurance premium" as additional consumer tax (ACT) in order for the government to invest and therefore prevent the decline in the number of wild species in risk of extinction.

Consumers who stated a positive ACT_{AFAs} wish to assure the future persistence of the species threatened with extinction according to some of the conventional degrees established by institutions and experts [24]. It was simulated that the ACT_{AFAs} is raised through an annual charge (e.g., tax) to adult persons resident in Andalusian households. In return for this payment the consumers hope to avoid/mitigate a one-species increase in the number of threatened species (Q*), which stood at 224 recorded at the opening and closing of the 2010 period in the Andalusian forest areas (AFAs) [12] (Figure S12: Non-parametric function for revenue from landscape conservation and threatened biodiversity preservation) [24].

The ACT_{AFAs} of the landscape and biodiversity are separated for econometric procedures [12] (Table S3: Extended production account of Andalusian forests). The simulated additional marginal willingness to pay for any individual threatened species s ($ACTs_{AFAs}$) is estimated assuming that all the species have the same transaction value in the AFAs as a whole. The simulated additional marginal willingness to pay per unit area of presence (As_{AFAs}) of the species s ($ACTsa_{AFAs}$) is estimated by dividing up the $ACTs_{AFAs}$.

The $ACTs_{SP}$ of an individual threatened species s in the areas of *Pinus pinea* (SP) forest in Andalusia is estimated by multiplying its $ACTsa_{SP}$ by the area in which it has a relevant presence (As_{SP}). Finally, the estimation of the ACT_{SP} of the quantity (Q^*_{SP}) of threatened species in the Andalusian SP concludes with the summation of the individual $ACTs_{SP}$ of all the species:

$$ACTs_{AFAs} = ACT_{AFAs}/Q^*_{AFAs} \tag{1}$$

$$ACTsa_{AFAs} = ACTs_{AFAs}/As_{AFAs} \tag{2}$$

$$ACTs_{SP} = ACTsa_{AFAs} \times As_{SP} \tag{3}$$

$$ACT_{SP} = \sum_{s=1}^{104} ACTs_{SP} \tag{4}$$

Given the TC, and the ACT exchange values, the O* is estimated directly by aggregating these TC and ACT transaction values (Figure 1, Tables 1, A1 and A2).

The refined SEEA (rSEEA) key concepts and accounting identities that make it possible to estimate the threatened biodiversity output are summarized in Table 1. The production and generation of income accounts estimate the gross values added (GVA) and net values added (NVA), respectively.

The production account for biodiversity registers the output including the final output consumed (FOc) valued at social price, defined as the simulated market price (FOc) and the own account manufactured (produced) gross fixed capital formation (GFCF) valued at the total investment cost price (TCi) (Table 1):

$$O = FOc + GFCF \tag{5}$$

The final output consumed (FOc) of biodiversity demand estimates the output of each single species (not that of the overall individuals of each species) revealed/stated by the passive consumers who wish to assure their future persistence across the total area in which its presence is relevant [19] (pp. 41–45). The FOc originates in the enjoyment provided to the consumers associated with avoiding and/or mitigating the species extinction risk through their direct and indirect voluntary contributions via the ecosystem trustee (as the government institution that administers the biodiversity collective property rights, subrogated in the name of society as a whole). The FOc of the biodiversity is estimated by summing the ecosystem trustee ordinary produced total cost (TCo) and the passive consumers' marginal willingness to pay the ACT (Figure 1, Tables 1, A1 and A2).

Given the ecosystem trustee ownership condition of being a free access public service, the final output consumed (FOc) of the biodiversity demand can only be registered in the production account of the ecosystem trustee. The difference between the final output (FO) and the intermediate consumption (IC) provides the gross value added (GVA). The net value added (NVA) contains the operating incomes of the labour and the operating capital benefit termed net operating surplus (NOS) in the SNA and SEEA (Table 1). The produced total cost (TC) incorporates the ordinary total costs (TCo) and the investment total costs (TCi). This circumstance means that the ordinary benefit (Bo) and the total benefit (B) coincide due to having assumed that the benefit (NOSi) of the GFCF is zero in the accounting period (Table 1).

$$TC = IC + LC + D \tag{6}$$

$$TC = TCo + TCi \tag{7}$$

$$B = O - TC = FOc - TCo \tag{8}$$

$$B = PB + EB \tag{9}$$

The components of the B are the operating produced benefit (PB) of manufactured (produced) capital and environmental benefit (EB) of the ecosystem asset. The latter is called ecosystem service (ES) in the SEEA. A competitive real profitability rate (e.g., 3%) chosen subjectively by the analyst is imputed to the produced capital to estimate the imputed competitive PB. By subtracting the PB from the B, the residual value of the EB (or ES) is estimated directly, as long as the difference is positive. If not, then the B coincides with the PB and the EB has a value of zero (Table 1).

3. Output and Net Value Added Results for Biodiversity in *Pinus pinea* Forests

3.1. Rationale of Public Management of the Pinus pinea Forests of Andalusia

In Andalusia, the area occupied by habitats with the presence of *Pinus pinea* is currently at its historical maximum. Reforestations of Stone pine on the Atlantic coast have been documented going back to the early Middle Ages with the aim of generating intermediate service outputs to protect against the advance of moving dunes as well as the final output of wood supply for the fishing industry of the Atlantic coast [25]. In the last third of the nineteenth century and over the course of the twentieth century, governments in Spain adopted policies of reforestation in the form of pure stands as well as stands mixed with species of the *Quercus* genus and such policies have been continued over the past four decades by the government of Andalusia. Based on the new legislation relating to forestry and the protection of natural areas, the government of Andalusia has been pursuing policies to increase public areas and invest in forests since the1990′s. In this context, Stone pine is one of the native species of the genus *Pinus* with the greatest expansion [26,27].

Historically, the dominant final use of Stone pine forests has been the production of wood, charcoal, pinecones, game hunting, honey, aromatic herb essences, livestock grazing, and mitigating the advance of moving dunes on the Atlantic coast. Since the early 1990's the objectives of the Andalusian government policies have changed, adapting to market trends such as loss in commercial profitability of timber and the emerging final demand of consumers for public services of landscape conservation in Spanish and European society [22,23,28]. The management of Stone pine forests in Andalusia is currently orientated towards improving the production of intermediate and final services. Among the intermediate services are those of conservation forestry by non-industrial private landowners who thereby improve their enjoyment of the final consumptions of recreational hunting and private amenities. These public investments in conservation forestry normally involve agreements between the government of Andalusia and the private or public landowners [29]. The greater part of the investment in conservation forestry is undertaken by the government of Andalusia in public farms with the aim of maintaining and improving the final consumption of public services of the Stone pine working landscape [26].

The presence of Stone pine forests is currently documented in a given territory based on the criteria of spatial scale and dominance attributes of the trees in terms of tree density and age (see detailed technical report by the [26]).

In this case study research, we quantified the area of Stone pine in Andalusia based on map tiles of the Spanish Forest Map (MFE) and on the third National Forest Inventory (NFI). In this article the areas of *Pinus pinea* refer to those where it is the main species within the map tiles, either in the form of pure or mixed stands (Tables 2 and A1). The areas of *Pinus pinea*-dominated map tiles are classified into protected areas (SP_{PAs}) and non-protected areas (SP_{NPAs}). Pure stands account for around 50% of the area of *Pinus pinea* in non-protected areas while they make up less than 30% in protected areas (Table A1). Mixed stands of *Pinus pinea*, with one or two species of trees, account for 65% and 46% of the areas of the SP_{PAs} and $SP_{NPAs,}$ respectively. Species of the *Quercus* genus predominate in the mixed stands, making up 40% in the SP_{PAs} and 20% in the SP_{NPAs} (Table A1).

Table 2. Andalusian Stone pine protected and non-protected areas (2010).

Class	Protected Areas (SP_{PAs})		Non-Protected Areas (SP_{NPAs})		Ratio
	(ha)	(%)	(ha)	(%)	SP_{PAs}/SP_{NPAs}
Pinus pinea without secondary species	41,616	29.8	49,343	47.6	0.8
Pinus pinea without tertiary species	55,558	39.7	32,224	31.1	1.7
Pinus pinea with tertiary species	35,294	25.2	15,498	14.9	2.3
Others	7367	5.3	6657	6.4	1.1
Total	139,836	100.0	103,723	100.0	1.3

Note: 70% of the areas of both SP_{PAs} and SP_{NPAs} are publicly owned.

Collective ownership of forests by public and private institutions was decimated during the process of expropriation of the land in Spain, which lasted until the end of the first third of the twentieth century. The most important exception of privatization of Mediterranean forest in Spain is the catalogue of forest land for public use, which since 1859 has provided a tool for implementing forest policies to fight against erosion and the advance of dunes on the Atlantic coast (see locations of Stone pine forests in Sierra Morena and Atlantic coast in [26]) (Figure 3, p. 32, Figure 4, p. 40, Figure 5, p. 40). Today, publicly owned forests of Stone pine dominate among those of individual species in public forests of Andalusia, accounting for 70% in both protected and non-protected areas (Tables 2 and A1).

The eight classes of protected area can be differentiated into three groups according to the level of intervention. The first is the national park, which includes in its management plan the avoidance of extraction by humans of live woody stocks and wild animals. The exceptions to this are those extractions undertaken for technical reasons associated with the management of wildlife compatibility, mitigating undesired damage due to competition, epidemics among wild species, and damage to the abiotic environment. The second is the natural park, with regulations that meet the requirements of the European Landscape Convention and which are aimed at the continuation of economic activities compatible with the persistence of wildlife and the natural environment [28]. In the six remaining categories of protected areas of *Pinus pinea* in Andalusia the regulations regarding economic activities are more permissive than in the case of natural spaces (Table 3).

Table 3. Classification and ownership of protected areas of Andalusian Stone pine (2010: ha).

Class	Publicly Owned (SP_{PAs})	Privately Owned (SP_{NPAs})	Stone Pine Forests (SPs)
Non-protected areas	72,985	30,738	103,723
Protected areas	97,850	41,986	139,836
Sites of Community Importance (SCI)	43,261	24,565	67,827
Protected landscape	396	321	716
Natural Site	2408	685	3092
National Park	7185	1537	8722
Natural Park	42,178	14,828	57,006
Concerted Natural Reserve	115	0	115
Protected zone	1360	13	1373
Buffer protected area of National Parks	946	37	983
Total	170,835	72,724	243,559

The new laws for protected natural areas in Andalusia incorporate silviculture aimed at the preservation of unique wild species of flora and fauna in danger of extinction risk as part of forest management in accordance with the European Union legislation and other international treaties on the protection of wildlife [24,30].

3.2. Economic Results for Pinus pinea Biodiversity

In this article we focus on the estimation of the existence value output, at the simulated transaction price, of the preservation service for unique wild species threatened with extinction risk in of the most valuable habitats in Andalusia, which is the Stone pine forest in protected as well as non-protected areas (Table A1).

Interpreting the comparative economic results for the threatened biodiversity of Stone pine forests in protected and non-protected areas of Andalusia is complex given the nature of the overall production and the subjective criteria adopted by an analyst in relation to the quantification of the passive consumers' scope.

Although the ownership of the SPs is distributed equally among the protected and non-protected areas, it is in the former that the government, through the ecosystem trustee, invests to a greater extent in management aimed towards the preservation of species in danger of extinction. The final output (FO) and the final output consumed (FOc) of the threatened biodiversity are 50% greater in the protected areas and the produced fixed investment (GFCF) is double that of the non-protected areas (Table 4).

The additional consumer willingness to pay tax (ACT_{SP}) for the biodiversity is estimated for 104 species in their respective individual areas in the SPs (As_{SP}) in which they are present across the total of 243,559 hectares, this being the sum of the area of Andalusian map tiles with a predominance of *Pinus pinea* forest, 57% of which corresponds to protected areas (SP_{PAs}) and 43% to non-protected areas (SP_{NPAs}) (Table A2). Five threatened biological species in the SP_{PAs} and nine in the SP_{NPAs} fall short of an exchange value for the ACTs which is equal to or greater than one EUR per hectare due to their low As_{SP} (Table A2).

Table 4. Sequence of total income accounts for threatened wild biodiversity under the refined SEEA applied to protected areas (SP_{PAs}) versus non-protected areas (SP_{NPAs}) of Andalusian Stone pine (2010).

Class	Protected Areas	Non-Protected Areas	Ratio
	SP_{Pas} (€/ha)	SP_{NPAs} (€/ha)	SP_{PAs}/SP_{NPAs}
1. Output at social prices (O*)	21.0	14.0	1.5
1.1 Additional consumer tax (ACT)	8.8	8.1	1.1
1.2 Total cost (TC)	12.2	5.9	2.1
2. Intermediate consumption (IC)	3.4	1.8	1.9
2.1 Raw material (RM)	0.1	0.0	4.0
2.2 Services (SS)	3.3	1.8	1.8
3. Gross valued added (GVA)	17.6	12.2	1.4
4. Depreciation of produced durable capital (D)	1.5	0.6	2.6
5. Net valued added at social prices (NVA)	16.1	11.6	1.4
5.1 Labour cost (LC)	7.4	3.5	2.1
5.2 Benefit (B)	8.8	8.1	1.1
5.2.1 Produced benefit of durable capital (PB)	0.7	0.1	5.6
5.2.2 Environmental benefit of durable ecosystem asset (EB)	8.0	8.0	1.0
6. Total cost (TC)	12.2	5.9	2.1

Note: B is additional consumer tax (ACT) and EB is synonymous with ecosystem service (ES).

The ACT (which is equivalent to the net operating surplus) is 10% higher in the protected areas (Table 4). This difference in the values of the ACT_{SP} between the SP_{PAs} and SP_{NPAs} can be explained based on the other associated vegetation in the map tiles dominated by the Stone pine forest, their specific locations, and the differences in the amounts of produced investment by the ecosystem trustee.

The government (ecosystem trustee) is directly responsible for the total cost (TC) of threatened biodiversity management. The three components of the TC, that is, intermediate consumption (IC), labour cost (LC), and depreciation (D) of produced durable goods (fixed capital) in the protected areas are 1.9, 2.1, and 2.6 times greater than those of the non-protected areas, respectively. The own ordinary intermediate consumptions of services (SSoo) are of scarce quantity. The total cost (TC) for protected areas is 2.1 times that of the non-protected areas.

The net value added (NVA) of the protected areas is 1.4 times that of the non-protected areas. The incomes from labour in the case of the SP_{PAs} are 2.1 times those of the SP_{NPAs}. The operating benefit (B) is distributed spatially, the values depending on the amount of investment by the government (Figure 2). The produced benefit (PB) of the protected areas is 5.6 times greater than that of the non-protected areas, this being the reason why the environmental benefit (EB) coincides by chance for the SP_{PAs} and SP_{NPAs} of Andalusia in the 2010 period. Since the same species are present in both areas, the reason is that there is more public spending on preserving biodiversity in protected areas and therefore more produced benefit (PB) from produced capital and employee labour cost (LC).

The EB account for 42% of the final outputs consumed (FOc) in the protected areas and for 61% in the non-protected areas. The EB make up 50% of the NVAs in the protected areas and 69% in the non-protected areas.

The steady state situation in the number of the threatened wild species in the accounting period explains the fact that the capital gain value is close to zero, all else being equal. In this circumstance the net value added and the total income nearly coincide, as do the environmental benefit (ecosystem service) and the environmental income. Thus, in the Stone pine forests of Andalusia, the net added value is a measure of the total income from biodiversity, implying that sustainable management is achieved in both economic and biological terms.

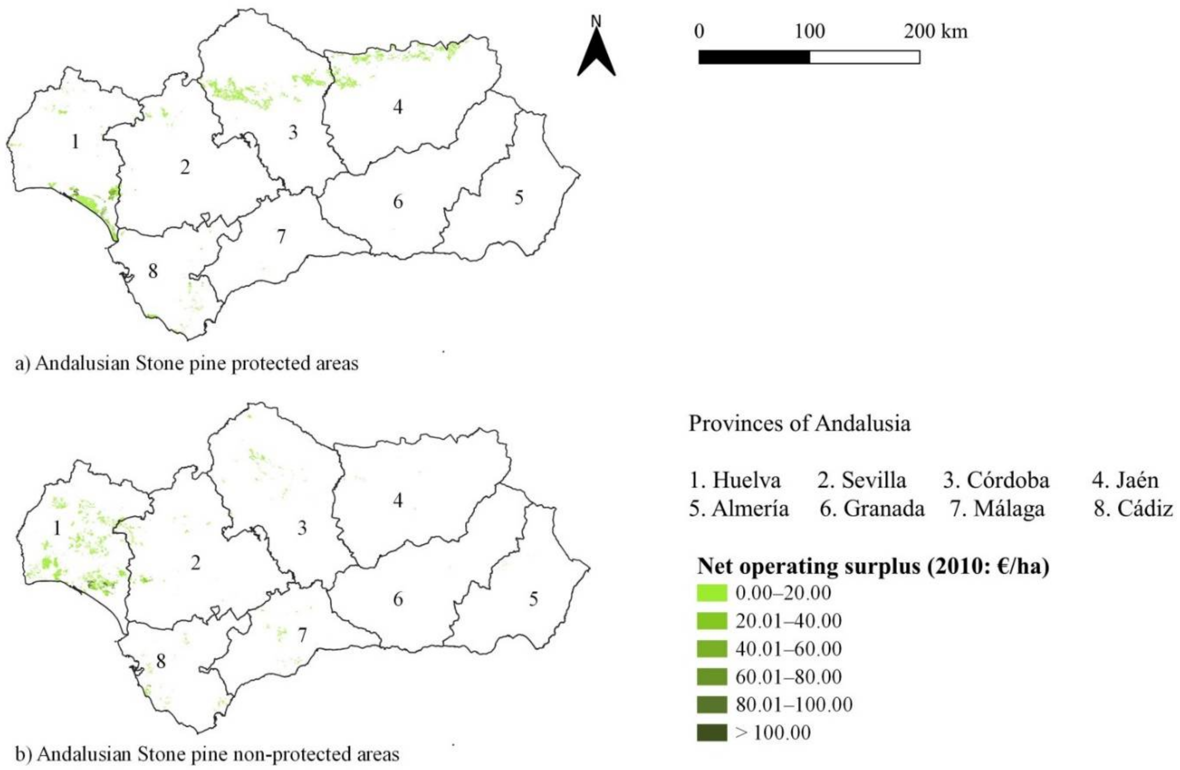

Figure 2. Map of the benefits of Stone pine forests in protected (SP_{PAs}) and non-protected (SP_{NPAs}) areas of Andalusia.

4. Discussion of the Advances in Methods Applied and Estimated Results

4.1. The Omission of the Benefit of Biodiversity in the SEEA Guidelines

The existence of a transaction price for the demand function of the final output consumed of biodiversity is rejected by some of the academic community and specialized statistical institutions such as the United Nations (see [5,17]) and academic authors (see [19]). The SEEA [5] relates the role of the biodiversity components to the condition of the natural production factors embedded in the nature-based outputs consumed in the present, apart from the existence value output: "the SEEA EA adopts the CBD (Convention of Biological Biodiversity) definition of biodiversity which recognises ecosystem, species and genetic diversity as the broad components of biodiversity. These components of biodiversity are not considered ecosystem services in themselves but there are distinct elements within these components that can be directly linked to ecosystem service supply" [5] (para. 6.60, p. 135). Thus, the SEEA focuses on the role of the physical accounts of biodiversity in order to provide information on the biological sustainability of ecosystem natural resource consumption in the period and simulated expected trends of future consumption: "the SEEA EA supports discussion on the link between biodiversity and economic activity and human wellbeing by providing a description of the relationships between ecosystems, the species that comprise them, and the SNA and non-SNA benefits that ecosystems provide" [5] (para. 13.41, p. 281).

The SEEA does not modify the SNA valuation of the output consumed of threatened biodiversity according to the purchased ordinary total cost (TCo) to the government [5,17]. Therefore, the SEEA omits the estimation of the benefits of existence value output of the threatened biodiversity embedded in the final output consumed (FOc): "while recognising the importance of genes and their diversity in underpinning ecosystem function and the flow of ecosystem services, the development of accounts for the genetic level of biodiversity has not yet been advanced. However, as data on genetic material for selected species becomes more widely available, the use of accounting to frame the connection to economic and human activity and wellbeing may be of relevance" [5] (para. 13.41, p. 281). The

SEEA recognises an intrinsic value of unique genetic variety which, not being related to people, does not have economic exchange value: "the purpose in accounting for biodiversity includes informing conservation actions and the enhancement of biodiversity as an environmental management objective in its own right" [5] (para. 13.16, p. 277). However, the threatened biodiversity can have a hidden exchange value when human actions reveal/state a demand for the preservation of species. In this situation, while maintaining an intrinsic value for the ecologic functions, the human action here is aimed at satisfying the demand for final output consumption of the species.

The biodiversity output that counts is that which is motivated by the desire to assure its indefinite persistence, and this is linked to the critical stock of individuals in their natural habitat [31]. In the case of species where the number of individuals is maintained above the amount considered critical to reveal threat of species extinction, there is no biodiversity output. The SEEA recognises that "the relationship between changes in ecosystem extent and ecosystem condition and changes in the suitable habitat available for individual species or species extinction risk can be made explicit" [5] (para. 13.32, p. 279). This role of complementing the physical accounts of biodiversity excludes its biodiversity output incorporation in the monetary accounts of the SEEA: "species accounts can therefore readily complement the other information, especially concerning economic activity and human wellbeing in accounting for biodiversity" [5] (para. 13.32, p. 280).

In this article we argue that, apart from the contributions of threatened biodiversity to the environmental benefit embedded in other outputs recognised by the SEEA and generated in the ecosystem accounting area, it is consistent to measure the demand for threatened biodiversity output at the simulated demand transaction price. Consequently, we maintain that it would not be for reasons of inconsistency with the concept of income if the environmental benefit embedded in the final output consumed of threatened biodiversity were kept out of the monetary measurements of the SEEA.

4.2. Uncertainty in the Estimation of the Threatened Biodiversity Demand

The government-subrogated demand for threatened biodiversity includes the demand from the European Union consumers who "pay" for their consumption of the final output consumed of threatened biodiversity in the Stone pine forests of Andalusia through the European Community budget (e.g., *Lynx pardinus* L.). The difference between this lower bound (total cost) of the demand for biodiversity and the upper bound (output) of the demand from consumers in member states of the European Union was estimated in this research only as the additional willingness to pay additional consumer tax (ACT) stated by the adult population of Andalusia. The choice experiment survey carried out in the rest of Spain and four other European Union countries (own unpublished data) as part of the RECAMAN project [32]; the experiment on threatened biodiversity in the forests of Andalusia, uncovered positive marginal willingness to pay additional passive consumer tax (ACT), which confirms the benefits embedded in threatened wild biodiversity output not only in Andalusia but also the rest of Spain and European countries as a whole. The results obtained in this Andalusian Stone pine forests research regarding the total demand for biodiversity in Andalusia are conservative values and it is to be expected that given the global nature of threatened biodiversity preservation, the benefits perceived by the population concerned as a whole are greater than those estimated in this research stated by Andalusian resident households.

4.3. Towards the Management of Biodiversity Based on Economic-Environmental Accounting

Over recent decades, management by the Andalusian government has successfully maintained stability in the number of species in danger of extinction, although this situation may not be assured if the degradation of *Pinus pinea* habitats on the Atlantic coast persists. The challenge faced by the government regarding the sustainable management of threatened biodiversity in the *Pinus pinea* forests is that of implementing policies restricting the use of water for crop irrigation and land use changes on the Atlantic coast, such policies are being rejected by a large proportion of the local population. In this situation, in which there is a high risk of extinction of biodiversity, the government must address the probability of extinction as an unacceptable irreversibility based on the precautionary principle. If the government total cost of avoiding this irreversibility is tolerable to the society concerned as a whole, then it is licit for the government to take measures to avoid it, even though this can lead to a loss of income to current generations. The argument in this case is that it is the government, on the basis of the precautionary principle, and not the individuals who comprise the current generations, that is the guarantor of preserving the species legacy which must where possible be transmitted to future generations.

The custody of the threatened biodiversity by the government, having the attribute of subrogated exclusive property right over the final output consumed, is configured as an economic activity additional to other activities that may be generated in the ecosystem accounting area as well as beyond the area, to which the populations of wild flora and fauna contribute. It should be concluded from the arguments expressed in the above sections that, given the subrogated property and transmission rights of the ecosystem trustee (government as fiduciary of the legacy of threatened biodiversity), the existence value output of the threatened biodiversity meets the requirements of the exchange value as required in the economic valuation principles of our refined System of Environmental-Economic Accounting.

A part of the academic community and the statistical offices of the United Nations does not accept the simulated transaction price of the final consumed output of the threatened biodiversity preservation services. We show in this article that this omission is not based on the advances made in recent decades regarding methods of valuing public services without market prices. It is true that the measurement of the environmental benefit of biodiversity requires the conjunction of multiple methodologies and complex subjective modelling, the total cost of the production function, and the simulated demand of passive consumers. Intuitively explaining this complexity of measuring the benefit generated by the consumed final output of threatened biodiversity justifies the fact that certain assumptions and simplifications must be adopted in the reasoning and development of the non-market output valuation methods.

5. Conclusions

The results show that in the 2010 period no changes in land use or the number of threatened species were registered in the SPs. The estimated economic indicator values for the biodiversity are notably higher in the protected areas than in the non-protected areas, with the exception of the environmental benefit (ecosystem services). It should be noted that it is coincidental that the estimated values per unit area for the environmental benefit of biodiversity are the same for the protected and non-protected areas of the Andalusian SPs. It should not be concluded from this result that the ecological functions of protected and non-protected areas are also equivalent. While in economic terms the transaction price expresses the comparison of equivalence between the items exchanged as a single numeraire (e.g., monetary), this is not the case for biophysical functions of wildlife existence. Species need to feed, rest, sleep, nest, and protect themselves from predators, among other requirements, these necessities are not exchangeable (at least in their totality) in order to derive equivalent exchange value in a single numeraire. It would appear paradoxical that people are willing to pay more for the biodiversity of a protected area of Stone pine while at the same time the same residual amount is estimated to remunerate the ecosystem services in the protected and non-protected areas of SPs in Andalusia that they consume for free.

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Appendix A

Table A1. Map tile area with predominance of Andalusian Stone pine in protected (SP_{PAs}) and non-protected areas (SP_{NPAs}) (2010).

Class	Protected Areas (SP_{PAs})		Non-Protected Areas (SP_{NPAs})	
	(ha)	(%)	(ha)	(%)
Without secondary species	41,616	29.8	49,343	47.6
Quercus ilex	48,618	34.8	11,441	11.0
Without tertiary species	32,389	23.2	7315	7.1
With tertiary species	16,229	11.6	4126	4.0
Quercus suber	7242	5.2	9453	9.1
Without tertiary species	5058	3.6	5581	5.4
With tertiary species	2184	1.6	3871	3.7
Quercus faginea	1364	1.0	12	0.0
Without tertiary species	441	0.3		0.0
With tertiary species	923	0.7	12	0.0
Olea europaea	3168	2.3	2029	2.0
Without tertiary species	1265	0.9	1359	1.3
With tertiary species	1902	1.4	671	0.6
Pinus halepensis	779	0.6	3446	3.3
Without tertiary species	475	0.3	1846	1.8
With tertiary species	305	0.2	1600	1.5
Pinus pinaster	17,195	12.3	3448	3.3
Without tertiary species	6935	5.0	1620	1.6
With tertiary species	10,260	7.3	1828	1.8
Eucalyptus camaldulensis	2415	1.7	5200	5.0
Without tertiary species	1394	1.0	4479	4.3
With tertiary species	1021	0.7	721	0.7
Eucalyptus globulus	2459	1.8	11,947	11.5
Without tertiary species	1924	1.4	9672	9.3
With tertiary species	535	0.4	2274	2.2
Juniperus phoenicea	5807	4.2	40	0.0
Without tertiary species	4837	3.5	40	0.0
With tertiary species	970	0.7		0.0
Juniperus oxycedrus	828	0.6	97	0.1

Table A1. *Cont.*

Class	Protected Areas (SP_{PAs})		Non-Protected Areas (SP_{NPAs})	
	(ha)	(%)	(ha)	(%)
Without tertiary species	418	0.3	43	0.0
With tertiary species	410	0.3	55	0.1
Arbutus unedo	978	0.7	609	0.6
Without tertiary species	423	0.3	269	0.3
With tertiary species	555	0.4	340	0.3
Others	7367	5.3	6657	6.4
Total	139,836	100.0	103,723	100.0

Table A2. Marginal willingness to pay additional consumer tax (ACT) for single threatened biological species in protected (SP_{PAs}) and non-protected areas (SP_{NPAs}) of Andalusian Stone pine forest (2010).

Number	Species	Degree of Threat (*)	Unit Values of $ACTsa_{AFAs}$ by Single Species in Andalusian Forest Areas	Protected Areas (SP_{PAs}): Presence of the Threatened Species in Protected Areas ($As_{PAs,SP}$)	Protected Areas (SP_{PAs}): Values of $ACTs_{SP}$ by Species (SP_{PAs})	Non-Protected Areas (SP_{NPAs}): Presence of the Threatened Species in Non-Protected Areas ($As_{NPAs,SP}$)	Non-Protected Areas (SP_{NPAs}): Values of $ACTs_{SP}$ Per Species in Protected (SP_{PAs}) and Non-Protected (SP_{NPAs}) Areas of Andalusian Stone Pine
			(€/ha)	(ha)	(€)	(ha)	(€)
1	*Abies pinsapo*	EN	15.0	2	30	0	0
2	*Aegypius monachus*	EN	2.2	16,905	38,684	5878	13,031
3	*Apus caffer*	VU	5.4	177	980	292	1593
4	*Aquila adalberti*	CR	0.3	83,521	31,365	19,440	5913
5	*Aquila chrysaetos*	VU	0.2	24,237	7690	2780	683
6	*Armeria velutina*	VU	3.2	27,862	90,411	14,766	46,861
7	*Baetica ustulata*	VU	1.0	4516	4950	900	923
8	*Bubo bubo*	NT	0.2	4749	1297	7234	1459
9	*Bufo calamita*	LC	0.1	5482	851	8081	677
10	*Canis lupus*	CR	0.4	73,680	39,652	1006	470
11	*Capreolus capreolus*	VU	0.7	26,858	22,084	3719	2792
12	*Caprimulgus europaeus*	VU	3.5	270	959	185	644
13	*Carduus myri-acanthus.*	VU	37.6	291	10,953	54	2026
14	*Centaurea citricolor*	EN	76.8	318	24,439	0	0
15	*Chalcides bedriagai*	NT	0.3	3586	1312	6091	1794
16	*Ciconia nigra*	EN	0.7	10,270	8528	9669	7339
17	*Circaetus gallicus*	NT	0.2	5690	1933	5741	15,340
18	*Circus aeruginosus*	EN	1.9	2331	4642	3068	5892

Table A2. *Cont.*

Number	Species	Degree of Threat (*)	Unit Values of $ACTsa_{AFAs}$ by Single Species in Andalusian Forest Areas	Protected Areas (SP_{PAs}) Presence of the Threatened Species in Protected Areas ($As_{PAs,SP}$)	Protected Areas (SP_{PAs}) Values of $ACTs_{SP}$ by Species (SP_{PAs})	Non-Protected Areas (SP_{NPAs}) Presence of the Threatened Species in Non-Protected Areas ($As_{NPAs,SP}$)	Non-Protected Areas (SP_{NPAs}) Values of $ACTs_{SP}$ Per Species in Protected (SP_{PAs}) and Non-Protected (SP_{NPAs}) Areas of Andalusian Stone Pine
			(€/ha)	(ha)	(€)	(ha)	(€)
19	*Circus pygargus*	VU	0.2	17	5	146	34
20	*Coluber hippocrepis*	NT	0.2	102	30	180	40
21	*Columba oenas*	EN	0.5	102	55	180	85
22	*Columba palumbus*	LC	0.1	6611	994	8550	675
23	*Coracias garrulous*	NT	0.1	583	108	767	88
24	*Coronella austriaca*	EN	5.6	10	57	0	0
25	*Corvus corone*	LC	0.1	1769	358	2067	271
26	*Corvus monedula*	LC	0.1	6611	1149	8550	875
27	*Culcita macrocarpa.*	EN	58.2	17	971	0	0
28	*Discoglossus galganoi*	NT	0.8	2563	2159	5580	4302
29	*Discoglossus jeanneae*	NT	1.4	1022	1513	940	1323
30	*Egretta garzetta*	LC	2.2	2936	6790	1855	4158
31	*Elanus caeruleus*	VU	0.1	4224	817	8076	985
32	*Eptesicus serotinus*	NT	4.1	1819	7702	1669	6951
33	*Erica andevalensis*	EN	3.1	573	1810	4692	14,487
34	*Euphydryas aurinia*	LC	1.4	80	115	637	878
35	*Falco naumanni*	NT	0.2	113	35	157	37
36	*Felis silvestris*	NT	0.1	3781	742	3486	436
37	*Festuca elegans*	NT	0.7	5249	3956	839	572
38	*Galerida theklae*	NT	0.1	6566	1533	8539	1383
39	*Gaudinia hispanica.*	VU	10.9	2313	25,426	2501	27,310
40	*Genetta genetta*	NT	0.1	75,021	12,870	49,541	4962
41	*Gyps fulvus*	LC	0.5	5741	3269	90	45
42	*Herpestes ichneumon*	LC	0.5	3973	2449	4268	2326
43	*Hieraaetus fasciatus*	VU	0.1	40,226	7242	8146	885
44	*Hieraaetus pennatus*	LC	0.1	139,596	32,908	103,588	17,025
45	*Hymenostemma pseudoan-themis*	VU	15.9	30	486	1067	17,026

Table A2. *Cont.*

Number	Species	Degree of Threat (*)	Unit Values of $ACTsa_{AFAs}$ by Single Species in Andalusian Forest Areas	Protected Areas (SP_{PAs}) Presence of the Threatened Species in Protected Areas ($As_{PAs,SP}$)	Protected Areas (SP_{PAs}) Values of $ACTs_{SP}$ by Species (SP_{PAs})	Non-Protected Areas (SP_{NPAs}) Presence of the Threatened Species in Non-Protected Areas ($As_{NPAs,SP}$)	Non-Protected Areas (SP_{NPAs}) Values of $ACTs_{SP}$ Per Species in Protected (SP_{PAs}) and Non-Protected (SP_{NPAs}) Areas of Andalusian Stone Pine
			(€/ha)	(ha)	(€)	(ha)	(€)
46	*Hypsugo savii*	NT	0.5	610	349	0	0
47	*Linaria tursica*	EN	5.0	5289	27,108	470	2378
48	*Lucanus cervus*	LC	1087.2	0	0	0	0
49	*Lullula arborea*	LC	0.4	6566	3079	8539	3394
50	*Luscinia svecica*	NT	0.3	2689	1046	6216	1973
51	*Lynx pardinus*	EN	1.1	42,854	49,594	20,272	22,013
52	*Macrothele calpeiana*	VU	2.6	220	589	1418	3693
53	*Micropyropsis tuberosa*	EN	17.1	2301	39,473	2967	50,681
54	*Milvus migrans*	NT	0.5	4486	2607	6120	3120
55	*Milvus milvus*	CR	2.5	334	871	0	0
56	*Miniopterus schreibersii*	VU	0.4	1090	500	2035	787
57	*Mustela putorius*	NT	0.1	52,966	11,560	34,187	5021
58	*Myotis blythii*	VU	0.5	1029	602	2321	1193
59	*Myotis emarginata*	VU	1.6	679	1,1278	68	108
60	*Myotis escalerai*	VU	2.4	3713	9280	6449	15,657
61	*Myotis myotis*	VU	0.3	1881	829	1610	594
62	*Narcissus fernandesii*	VU	0.7	1253	1006	0	0
63	*Narcissus humilis*	LC	0.8	1481	1336	7501	6230
64	*Narcissus triandrus*	LC	0.2	27,291	8196	3286	752
65	*Narcissus viridiflorus*	VU	16.2	115	1871	1225	19,884
66	*Neophron percnopterus*	CR	0.3	10,315	3892	2235	684
67	*Nyctalus lasiopterus*	VU	9.3	7849	73,867	2623	24,498
68	*Nyctalus leisleri*	VU	5.1	10,486	54,442	5315	27,214
69	*Nyctalus noctula*	EW	28.3	5638	159,838	2623	74,173
70	*Orobanche densiflora*	LC	0.3	8666	3187	9014	2671
71	*Otis tarda*	CR	0.3	755	293	1207	383
72	*Pandion haliaetus*	VU	11.2	413	4680	0	0
73	*Pelobates cultripes*	NT	0.5	3031	1676	6034	2906
74	*Pica pica*	LC	0.1	6598	1011	8545	699
75	*Picris willkommi.*	VU	38.9	0	0	214	8335

Table A2. *Cont.*

Number	Species	Degree of Threat (*)	Unit Values of $ACTsa_{AFAs}$ by Single Species in Andalusian Forest Areas	Protected Areas (SP_{PAs}) Presence of the Threatened Species in Protected Areas ($As_{PAs,SP}$)	Protected Areas (SP_{PAs}) Values of $ACTs_{SP}$ by Species (SP_{PAs})	Non-Protected Areas (SP_{NPAs}) Presence of the Threatened Species in Non-Protected Areas ($As_{NPAs,SP}$)	Non-Protected Areas (SP_{NPAs}) Values of $ACTs_{SP}$ Per Species in Protected (SP_{PAs}) and Non-Protected (SP_{NPAs}) Areas of Andalusian Stone Pine
			(€/ha)	(ha)	(€)	(ha)	(€)
76	*Pipistrellus kuhlii*	NT	8.9	1880	16,812	1281	11,368
77	*Pipistrellus pygmaeus*	DD	2.2	14,943	33,801	10,293	22,547
78	*Plantago algarbiensis*	NT	80.5	1872	150,803	2488	200,290
79	*Plecotus austriacus*	NT	2.5	431	1126	3424	8694
80	*Quercus alpestris*	EN	0.6	1080	770	1759	1129
81	*Rhinolophus euryale*	VU	0.3	1881	822	10,010	369
82	*Rhinolophus ferrume-quinum*	VU	0.2	4391	1110	5214	946
83	*Rhinolophus hipposideros*	VU	1.1	0	0	724	799
84	*Rhinolophus mehelyi*	EN	0.6	1161	835	1759	1139
85	*Salix salviifolia*	NT	3.0	1623	4963	1798	5369
86	*Scilla odorata*	NT	7.4	0	0	1760	13,106
87	*Scolopax rusticola*	LC	1.1	2116	2453	1798	1955
88	*Silene mariana*	VU	3.5	2623	9397	440	1545
89	*Silene stockeni.*	EN	4.2	0	0	623	2641
90	*Spiranthes aestivalis*	NT	1.3	949	1278	31	39
91	*Streptopelia turtur*	VU	0.4	6179	2969	7105	2907
92	*Sturnus vulgaris*	LC	0.1	6611	1024	8550	714
93	*Sylvia atricapilla*	NT	0.1	139,596	24,804	103,673	11,020
94	*Sylvia cantillans*	LC	0.2	339	112	264	68
95	*Sylvia communis*	NT	0.7	393	327	520	396
96	*Sylvia hortensis*	DD	1.5	57	92	86	132
97	*Sylvia melanocephala*	LC	0.1	139,596	19,920	103,673	7393
98	*Testudo graeca*	EN	0.7	24,263	20,337	2618	2005
99	*Thymus carnosus*	VU	36	302	10,880	813	29,268

Table A2. *Cont.*

Number	Species	Degree of Threat (*)	Unit Values of $ACTsa_{AFAs}$ by Single Species in Andalusian Forest Areas	Protected Areas (SP_{PAs}): Presence of the Threatened Species in Protected Areas ($As_{PAs,SP}$)	Protected Areas (SP_{PAs}): Values of $ACTs_{SP}$ by Species (SP_{PAs})	Non-Protected Areas (SP_{NPAs}): Presence of the Threatened Species in Non-Protected Areas ($As_{NPAs,SP}$)	Non-Protected Areas (SP_{NPAs}): Values of $ACTs_{SP}$ Per Species in Protected (SP_{PAs}) and Non-Protected (SP_{NPAs}) Areas of Andalusian Stone Pine
			(€/ha)	(ha)	(€)	(ha)	(€)
100	*Turdus iliacus*	LC	0.1	6566	1029	8539	729
101	*Turdus philomelos*	LC	0.1	6611	1033	8550	725
102	*Turdus torquatus*	LC	0.3	17,213	7577	12,981	4788
103	*Turdus viscivorus*	LC	0.1	139,121	32,887	101,481	16,745
104	*Turnix sylvatica*	CR	1.6	4963	8597	7534	12,512
Total			8.1	139,836	1,225,964	103,723	841,172

(*) Threat categories by the International Union for Conservation of Nature (IUCN) extracted from the Andalusian Red Books: EW: extinct in the wild; CR: critically endangered species; EN: endangered of extinction species; VU: vulnerable species (VU); NT: near threatened; LC: lower concern; DD: insufficient data.

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