Valuation of the ecosystems nature education service, valuation methods, present state and way forward, Estonia's case study

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Contents

Abstract

Development of the methodology and application of nature education ecosystem service is carried out as one part of the work under Eurostat grant-funded Knowledge Innovation Project on an integrated system for natural capital and ecosystem services accounting[1] in Estonia in 2019. Overview of the relevant studies and concepts for defining and valuation nature education service provided by ecosystems was created. The scope and the definition of the nature education service were formulated on the basis of the main findings of literature. Analyses of available socio economic data and a survey regarding *in situ* nature education was performed and geo-referenced database is now under formation. The criteria for classifying of spatial units on the bases of nature education service potential was developed as a precondition to value the educational potential of ecosystems and to develop the spatial delineation of the results. The criteria were agreed among project group and potential values of the ecosystem education services were valued on a point scale. Four parallel monetary valuation methods were applied and the gained results were compared, set in the supply use table format and discussed.

Summary

According to the classification of ecosystem services, education service is a cultural service (CICES V5.1)[2]. Based on the CICES classification the project group has agreed on the following definition: "The value of the ecosystem as an educational service provider is expressed by its ability to participate in nature education." The important criteria for the inclusion of the activity as an education service is the direct association of the educational activity with the natural ecosystem. In current work the operational definition was decided to be the actual volume of nature education provided by the (specific) ecosystem (area object) in physical and monetary units. The ecosystem component would be restricted to the nature education service provided directly in the ecosystem (i.e. the process of theoretical and practical learning of the relevant nature studies in which the information obtained from the ecosystem is involved). An indirect use, such as visiting a biodiversity/ natural history museum is excluded from the scope.

The scope includes institutionally organized nature education, self-learning is not included. The distinction between formal nature education (e.g. during school classes) and informal or private nature education is not made. The scope and dimensions for nature education service are adapted from the concept for cultural services by Fish et al[3].

Classification of spatial units relevant for nature education service was developed on the basis of the correspondence to the following criteria: 1) area is used for educational purposes and 2) area is mappable based on existing map layers.

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[1] http://ec.europa.eu/environment/nature/capital_accounting/index_en.htm

[2] Haines-Young, R. and M.B. Potschin (2018):Common International Classification ofEcosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure. Available from www.cices.eu

[3] Fish, R., Church, A., Winter, M., 2016 Conceptualising cultural ecosystem services: A novel framework for research and critical engagement. Ecosystem Services, Volume 21, Part B, 2016, Pages 208-217, ISSN 2212-0416, https://doi.org/10.1016/j.ecoser.2016.09.002

Enabling factors for nature education provisioning capacity were analyzed. Spatial units relevant for nature education service were evaluated based on their potential educational values (depending on the rarity, representativeness, diversity, scientific knowledge of the site and also on the availability of learning infrastructure and relevant products). Criteria for the evaluation of the educational values of spatial units relevant for nature education service were developed on the basis of reviewed literature (main input from Mocior & Kruse[4]).

We were thinking of how to address various qualities of nature education and related spaces. Each spatial unit relevant for nature education service (which is receiving students) is categorized according to the type and valued according to the criteria by the project team. To reflect the real value (quality) of the service better these location specific educational capacity/potential/condition factors should be taken into account to adjust the results of the monetary valuation methods where just socioeconomic indicators (educational visit numbers and expenditures made) were used in calculations.

The developed table (Table 5 "Categorization of nature education provisioning sites by nature education value") could be used as a basis for spatial distribution of nature education service values received by willingness to pay method. In future the applicability of the developed matrix for deriving of the potential capacity will be analyzed.

The aspects of the qualities (values) of nature education service and derived various estimates of nature education service value should be addressed in dialogue with wider ecosystem accounting community in Estonia and potential users in policy.

Estimation of the nature education ecosystem services *in situ* requires data about the number of people receiving nature education and the location of the sites where this is happening. In order to create the link between activities and sites, a survey and queries about available data were performed.

A nature education ecosystem service is one of the non-market services that does not produce a market product and therefore its monetary value could be well assessed by means expenditures made or stated preferences associated with the service. Unlike ecosystem recreational services, the distinctive feature of education services is that the financial costs of providing an educational service are relatively well defined and can be expressed as a specific amount of money. This is valid both for public education expenditure and for investments into nature education infrastructure in sites where the learning process takes place in contact with ecosystems. Due to above-mentioned aspects it was relevant to try a variety of methods for valuation. Applied methods for monetary valuation were as follows:

1. expenditure transfer approach
2. expenditure based approach
3. travel costs based approach
4. contingent valuation study: willingness to pay (WTP) for ecosystem services of Estonian grasslands

[4] Mocior, E. & Kruse, M. (2016). Educational values and services of ecosystems and landscapes – An overview. Ecological Indicators. 60. 137-151. http://dx.doi.org/10.1016/j.ecolind.2015.06.031

Future benefit (avoided cost) and time use based approach methods were discussed as well but the calculations were not performed.

In expenditure transfer approach, the expenditures of the public sector on education are attributed to the ecosystem according to the actual lessons taking place in contact with the ecosystem. The advantage of the approach is that the nature education service value is based on the actual expenditure on education and the number of student hours actually spent in the ecosystem. The disadvantage of the approach is that the concept is speculative and based on the assumption that the nature education service value is expressed through contact hours.

The second method, the expenditure based approach, is based on actual expenditures made to provide nature education in the ecosystems. Its strengths are that it is based on actual expenditures, the direct link between expenditure and nature education, and the possibility of linking expenditure to specific locations. The disadvantage is that this approach does not take into account other nature education expenditures (such as transport costs, labour costs) and should be combined with other methods to find out the total value of ecosystem as a provider of nature education (as there are other costs to be considered such as household expenditures).

The advantage of both cost-based approaches from the accounting point of view is that the value attributed to ecosystems is included in the SNA and the application of the methods does not require extensive specific research.

The travel cost based approach is also based on actual expenditures. Travel costs are widely used in the economic valuation of non-market values of nature. Classically implemented, the travel cost method is based on individuals' travel expenses, which are used to construct a demand curve for ecosystem service and to calculate aggregate demand. In our case there is a deviation from theory in evaluating ecosystem education service using the travel costs, as students who visit ecosystems for educational purposes do not make individual expenditures, but the trips are financed by the school or sponsor. It is also a question of what proportion of travel costs can be attributed to the educational value of the ecosystem. For example, it is not clear if it is appropriate to apply the concept that the educational value of the ecosystem equals with the profit of the carrier company, as carriers may be subsidized in Estonia. This method has the advantage of taking account of the actual costs and the possibility to allocate costs to specific locations.

The nature education service values found using three expenditure based approaches do not overlap in major part. When double-counting can be eliminated, in principle consideration may be given to sum them up in order to determine the total value of the nature education service. While summing up the values received by different methods one still has to consider that two expenditure approaches may overlap regarding some expenditures made by general government. Also overlapping is difficult to detect as the calculation logic of methods differ.

The fourth method used in this study was contingent valuation (CVM), which is a stated preference method and is widely used in estimating the non-market values of nature. The strength of the method is that it measures the welfare that ecosystem services provide to individuals. The disadvantage of the method is the poor relation to SNA and real turnover, which currently makes the integration of the values found by this method difficult with environmental

accounting. The implementation of the method also requires considerable costs. However, CVM is the method that measures the impact of the educational value of an ecosystem on well-being, so it measures value precisely according to the concept of welfare economics, so that everything that positively affects well-being has a value.

Another theoretical option for estimating the nature education service value based on the price of time is not well applicable to nature education service, since pricing a student's time is questionable unlike the wage earner's.

Results of the valuations carried out using several methods were analyzed further in the supply and use table framework. Contributions of the ecosystems were highlighted for each of the applied methods.

Integrating the results into supply and use table displays how the values obtained by expenditure based method and travel cost based approach were already recorded in national accounts and therefore did not raise total value added. Table showed that some of the value added that companies make from the nature education service actually comes from the ecosystems as they are using ecosystems as an input. The result of the willingness to pay method in contrary raises the supply, use and value added as it is not based on and related to real transactions and due to that is not recorded in national accounts.

The results of the expenditure transfer approach should in principle be already recorded in national accounts as the education expenditures made by the government are used as the basis of the calculation but the distinction between ecosystems and economic sectors was not made in this study due to the lack of data. Therefore the whole service value calculated by expenditure transfer approach was attributed to the ecosystems due to which the total value added, supply and use values rose. As some of the input values for calculation of the service value are already described in SNA, attributing the whole result may not be fully correct as it leads to possible double counting and therefore needs further analysis.

As the integration of the ecosystem service value to national accounts system is a novel idea then a concern remains whether the users and beneficiaries were captured correctly for all of the methods. Our view point for the distinction between the users and beneficiaries is as follows: while students that belong to households are the ones being educated and therefore using the service, they may also be considered as beneficiaries and then the actual users are the companies and government that use ecosystem education service as an input to supply the nature educational service to students.

Methodological issues were highlighted and proposed for the discussion for the London group.

Questions to the London Group

1. Is the conceptual framework (ecosystem plays the role of the “enabler” and society plays the role of the “shaper”) helpful when defining cultural ecosystem services, especially nature education service?
2. Can the number of visits and the number of contact hours be considered good indicators for measuring nature education service value?
3. How important is it to determine the area which supplies nature education? Are there acceptable criteria for assessing spatial units relevant for nature education service available? How to include the educational potential in assessing nature education service flow? What is the extent of the service supplying site (e.g polygon radius based on trail length)?
4. What indicators of condition would be relevant to the assessing the continuing capacity of the ecosystem to supply nature education services?
5. Is the assumption valid that the value of education is at least as big as expenditures made to obtain it?
6. How to find the share of the contribution of ecosystem from the total service value found with the non-market valuation methods?
7. Should the consumption of nature education service in the use table be attributed to households or rather to the companies that supply the educational service to households? Does the distinction between users and beneficiaries in the supply and use table depend on the methodology that is used to value the service?

Overview of the relevant studies and concepts for defining and valuation nature education service provided by ecosystems

Can nature education be regarded as an ecosystem service? It may be argued that nature education is a service provided by society for the benefit of society and hence not something which ecosystems contribute a value to. However, we suggest that the ability of the ecosystem to contribute to the supply of nature education service is an important feature and the estimated value of the service could be useful in decision making in planning processes when developing areas of interest. Despite the difficulties with definitions and assessment, the comparability and consistency with the valuation of other ecosystem services (provisioning, regulating and other cultural services) and ultimately the spatial distribution of the use of the service is desirable.

Nature education is one of the many services that ecosystems provide to societies as a cultural service. Whereas valuation methods for several ecosystem services are already well-developed, not much attention has been paid to nature education as an ecosystem service. Also System of Environmental-Economic Accounting –Experimental Ecosystem Accounting (SEEA EEA)[5] and methodological guidebook "Technical Recommendations in support of the SEEA EEA 2012 (SEEA EEA TR)"[6] do not provide clear guidelines and recommendations on the topic. Therefore, several questions regarding the definition, scope and methods for quantification of this service need to be considered.

Several studies, for example Böhnke-Henrichs et al. (2013)[7] and Fish et al. (2016)[8] conclude that ecosystems are contributing just partially to the provisioning of cultural services (including educational) and that the challenge is to single out the part of the service that ecosystem contributes. An empirical framework provided by Fish et al. emphasizes that the ecosystem plays the role of the "enabler" and society plays the role of the "shaper" in supplying cultural ecosystem services[9]. The framework is presented in Figure 1. This framework explains how to incorporate distinctive contributions of society and ecosystems in case of cultural (including nature education) ecosystem services. This ecosystems based approach supports both the conceptual complexity and varying geographical contexts. The framework is distinguished by its emphasis on the co-production and reciprocity of culture-nature relationships.

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[5] UN, EU, FAO, IMF, OECD and World Bank (2014) System of Environmental-Economic Accounting 2012: Experimental Ecosystem Accounting. New York, https://seea.un.org/sites/seea.un.org/files/seea_eea_final_en_1.pdf

[6] UN (2017) SEEA Experimental Ecosystem Accounting: Technical Recommendations Consultation Draft. New York, USA. https://seea.un.org/sites/seea.un.org/files/technical_recommendations_in_support_of_the_seea_eea_final_white_cover.pdf

[7] Böhnke-Henrichs, A., Baulcomb, C., Koss, R., Hussain, S.S., de Groot, R.S., 2013.Typology and indicators of ecosystem services for marine spatial planning and management. J. Environ. Manage. 130, 13–145, http://dx.doi.org/10.1016/j.jenvman.2013.08.027

[8] Fish, R., Church, A., Winter, M., 2016 Conceptualising cultural ecosystem services: A novel framework for research and critical engagement. Ecosystem Services, Volume 21, Part B, 2016, Pages 208-217, ISSN 2212-0416, https://doi.org/10.1016/j.ecoser.2016.09.002

[9] Fish et al. (2016)

Figure 1 Incorporation the distinctive contributions of society and ecosystems in case of cultural (and also education) ecosystem services. Source: A conceptual framework for cultural ecosystem services, Fish et al. (2016)

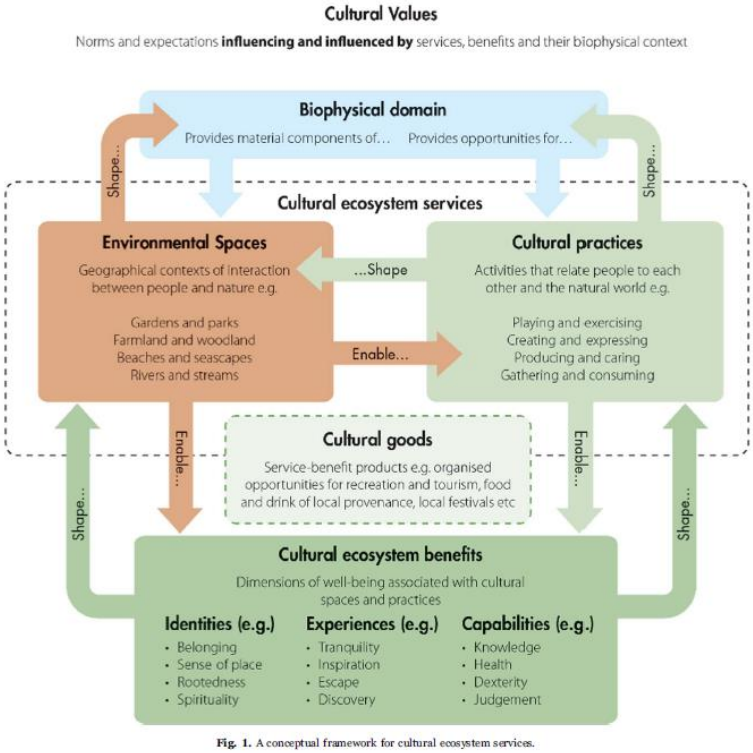

Fig. 1. A conceptual framework for cultural ecosystem services.

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The studies were looked for where the distinction between ecosystem service provisioning potential and real flow is made, latter referring to the actual use of ecosystem services. The illustrative ecosystem service potential and real flow matrices were well described in a study by Burkhard et al. (2014)[10]. The illustrative valuations refer to a hypothetical European "normal" landscape valued in a five points scale.

Mocior and Kruse[11] propose to distinguish separately both the values and the services in the case of nature education service. More precisely "educational values" have been seen as a potential of landscapes and ecosystems to provide the education service (i.e. opportunities for formal and informal nature education) and the ecosystem service flow reflects the real usage of landscape and ecosystems values for educational purposes. This study gives a good overview of the definitions of various educational values of landscapes and ecosystems, proposes useful criteria for the valuation analysis of nature education potential of nature areas and for classifying them into separate groups/classes according to the potential to provide education service.

[10] Burkhard, B., Kandziora, M., Hou, Y., Müller, F., 2014. Ecosystem service potentials, flows and demands – concepts for spatial localisation, indication and quantification. Landsc. Online 34, 1–32, http://dx.doi.org/10.3097/LO.201434

[11] Mocior, E. & Kruse, M. (2016). Educational values and services of ecosystems and landscapes – An overview. Ecological Indicators. 60. 137-151. http://dx.doi.org/10.1016/j.ecolind.2015.06.031

Regarding valuation methods relevant for the valuation of nature education service, there is a study regarding the educational values of ecosystems[12] using a travel cost approach covers a large number of students and one specific park (Hudson River Park) where environmental education programs were held by schools and summer camps. However, it is difficult to apply that approach in our work as we have an opposite situation: a lot of "parks"/sites and not so many students per park/site.

A recent study by Vallecillo et al. (2019)[13] discusses valuing nature-based short-distance recreation service in biophysical and monetary units. Recreation and nature education are both cultural services and the flow of the service from ecosystems to people is similar. In the study, first the ecosystem recreation service potential was derived from ecosystem-based potential, then the population's demand for the service based on the distance between the supply (considering only high-quality recreation service areas) and demand locations was modelled. The actual flow assessment and monetary valuation was done by applying a zonal travel cost method where travel expenses by car (cost of fuel) were used as an exchange price. The actual flow of the service was allocated between ecosystem types depending on the relative extent of ecosystems within the area suitable for recreation.

We also looked SEEA EEA guidelines[14], regarding the SNA approaches to valuing non-monetary transactions where market prices are not observable like the production of education and health services by government. Valuation according to market price equivalents provides a procedure for use, namely, the cost of production approach, in which the value of the non-monetary transaction is deemed to be equal to the sum of the costs of producing the good or service, that is the sum of intermediate consumption, compensation of employees, consumption of fixed capital (depreciation), other taxes (less subsidies) on production, and a net return on capital (2008 SNA, para. 6.125).

UN SEEA Experimental Ecosystem Accounting: Technical Recommendations Consultation Draft[15] suggests that in case of nature education service in biophysical terms, all services and benefits can be measured in terms of the number of people engaging in such activities.

We have been discussing with an expert group whether it would be reasonable to try to capture the future value of nature education in monetary terms. Taking an example from education economics, UN SEEA Experimental Ecosystem Accounting: Technical Recommendations Consultation Draft for an example from education economics (UN SEEA EEA TR, Chapter 6. 22,

[12] Hutcheson, W., Hoagland, P., Jin, D., 2018. Valuing environmental education as a cultural ecosystem service at Hudson River Park. Ecosystem Services, Volume 31, Part C, 2018, Pages 387-394, ISSN 2212-0416, https://doi.org/10.1016/j.ecoser.2018.03.005.

[13] Vallecillo, S., La Notte, A., Zulian, G., Ferrini, S., Maes, J., 2019. Ecosystem services accounts: Valuing the actual flow of nature-based recreation from ecosystems to people, Ecological Modelling, Volume 392, 2019, Pages 196-211, ISSN 0304-3800, https://doi.org/10.1016/j.ecolmodel.2018.09.023.

[14] UN, EU, FAO, IMF, OECD and World Bank (2014) *System of Environmental-Economic Accounting 2012: Experimental Ecosystem Accounting*. New York, USA, pages 144-145.

[15] UN (2017) *SEEA Experimental Ecosystem Accounting : Technical Recommendations Consultation Draft*. New York, USA, pages 10000.

6.23) suggests to valuate nature education services as a contribution of environmental education to the future benefit or income.

Also, in UN SEEA TR the question for discussion and investigation is whether a complementary set of ecosystem accounts in monetary terms might be compiled using non-exchange value concepts, namely so called welfare values. The starting logic would be that complementary accounts could be based on the same biophysical accounts (for ecosystem extent, condition and service flows) and then alternative valuation concepts that include consumer surplus could be applied to support particular policy contexts. The feasibility and relevance of such an approach has been debated in the expert group working on grant. Depending on the policy or decision-making context there is a need for presenting both exchange-based and welfare-based values. Willingness to pay method has supported policy analysis and decision making in Estonia for some time now. The contingent valuation method has so far been applied, for example, to determine the monetary equivalent of the values for Jägala waterfall (Ehrlich, Ü, Reimann, M, 2010[16]), shores in natural condition (Reimann, M, Ehrlich, Ü, 2012[17]) and biological habitats (Lepasaar, H, Ehrlich, Ü, 2015[18]).

UN SEEA EEA TR stipulates that values recorded in the national accounts for the production and consumption of education do not reflect the full welfare arising from this consumption. We are aware that currently in the national accounts monetary values do not reflect all generated welfare related to the value of nature education service provided by ecosystems. The use of exchange values to underpin macro-economic measurement and modelling is accepted by UN SEEA TR, as is the relevance of estimating welfare values in making decisions. For example in the assessment of costs and benefits for additional investments in the education system (UN SEEA EEA TR, 6.23).

The incurred expenditure method is an indirect method of economic valuation of non-market goods and values are based on revealed preference. Finding the monetary value of ecosystem education services through the spending of institutional education is based on the assumption that general education is a public service aimed at creating and improving the quantity and quality of human capital. We are not able to value the increase of human capital (due to nature education being an abstract concept and public goods) directly but we assume that the value of education is at least as big as expenditures made to obtain it.

The exchange-based and welfare-based valuations will be described in subsections of chapter “Nature education as ecosystem service, valuation”. The values recorded may have important deviations depending on the methods chosen and assumptions made.

Discussion paper 5.1: Defining exchange and welfare values, articulating institutional arrangements and establishing the valuation context for ecosystem accounting prepared by the experts as part of the work on the SEEA EEA Revision coordinated by the United Nations

[16] Ehrlich, Ü, Reimann, M. 2010. “Hydropower versus Non-market Values of Nature: a Contingent Valuation Study of Jägala Waterfalls, Estonia. International Journal of Geology. 2010. a., Kd. 4, 3.

[17] Reimann, M, Ehrlich, Ü. 2012. Public Demand for Shores in Natural Condition: a Contingent Valuation Study in Estonia. International Journal of Geology. 2012. a., Kd. 6, 1

[18] Lepasaar, H, Ehrlich, Ü. 2015. Non-market value if Estonian seminatural grasslands: a contingent valuation study. Estonian Discussion of Economic Policy. 2015. a., Kd. 23, 2

Statistics Division[19] was considered useful in order to analyze the meaning and comparability of the results of applied methods and related values. The suggestion that actual costs of management based on exchange values would constitute a lower bound for service value while maximum willingness to pay constitute an upper bound, was considered relevant.

The following chapter presents the definition of the scope and development of the concept in the current work on natural education ecosystem service by Statistics Estonia

Definition and the scope of the nature education

In the Common International Classification of Ecosystem Services (CICES) version 5.1 (Haines-Young and Potschin, 2018)[20], the education service is included within the ecosystem service defined as "information and knowledge".

Table 1 Environmental education is classified under the cultural ecosystem services according to CICES V5.1.

CICES Code	Section	Division	Group	Class	Class type
3.1.2.2	Cultural (Biotic)	Direct, in-situ and outdoor interactions with living systems that depend on presence in the environmental setting	Intellectual and representative interactions with natural environment	Characteristics of living systems that enable education and training	By type of living system or environmental setting

According to the ecological use clause in CICES definition: "The biophysical characteristics or qualities of species or ecosystems settings/cultural spaces that are the subject matter for in-situ teaching or skill development" environmental/nature education service is limited to *in situ* nature education service. The example service could be "site used for voluntary conservation activities" and the example goods and benefits "studying nature, skills or knowledge about environmental management".

Based on the CICES classification the project group has agreed on a following definition: "The value of the ecosystem as an educational service provider is expressed by its ability to participate in nature education." The important criteria for the inclusion of the activity as an

[19] Barton D.N., Caparrós A., Conner N., Edens B., Piaggio M., Turpie J. (2019). Discussion paper 5.1: Defining exchange and welfare values, articulating institutional arrangements and establishing the valuation context for ecosystem accounting. Paper drafted as input into the revision of the System on Environmental-Economic Accounting 2012– Experimental Ecosystem Accounting. Version of 25 July 2019. https://seea.un.org/sites/seea.un.org/files/documents/EEA/discussion_paper_5.1_defining_values_for_erg_aug_2019.pdf

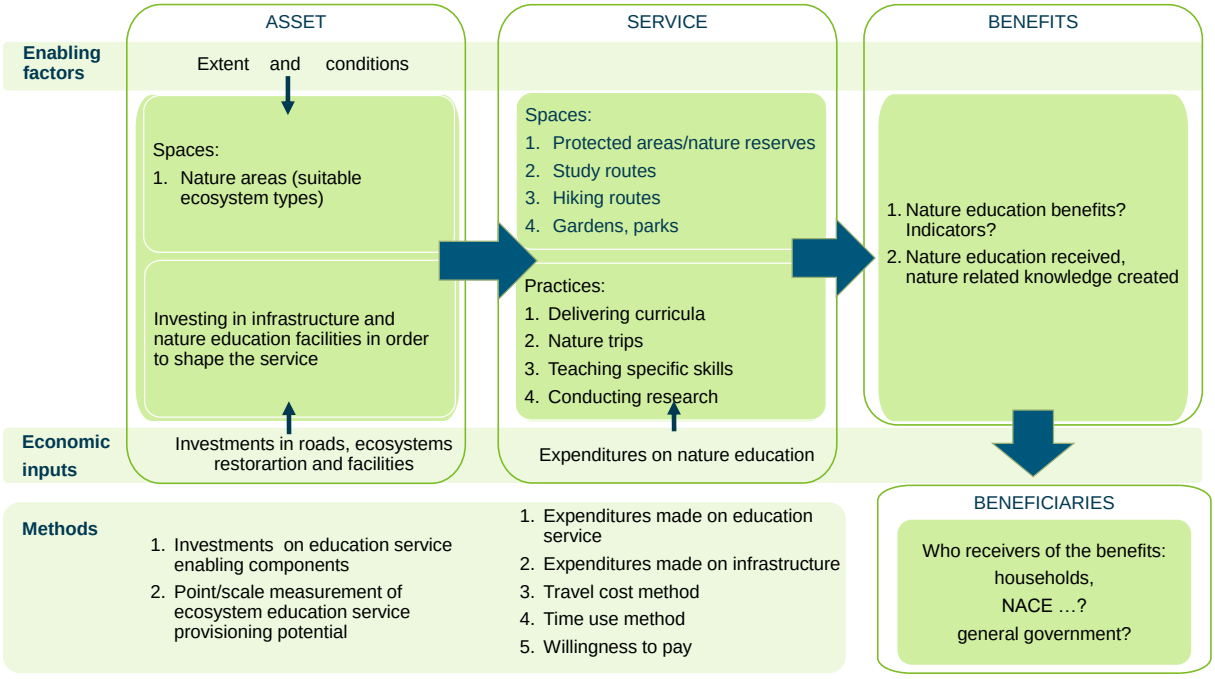
[20] Haines-Young, R. and M.B. Potschin (2018):Common International Classification ofEcosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure. Available from www.cices.eu

education service is the direct association of the educational activity with the natural ecosystem.

In current work the operational definition i.e. metric was decided to be the actual volume of nature education provided by the (specific) ecosystem (area object) in physical and monetary units. The ecosystem component would be restricted to the nature education service provided directly in the ecosystem (i.e. the process of theoretical and practical learning of the relevant nature studies in which the information obtained from the ecosystem is involved). An indirect use, such as visiting a biodiversity/ natural history museum is excluded from the scope.

The agreed scope of nature education service includes institutionally organized nature education, self-learning is not included. The distinction between formal nature education (e.g. during school classes) and informal or private nature education is not made. The framing of the scope and dimensions of the service is based on the concept of Fish[21] and is adapted for nature education service. The scheme of the service is presented on Figure 2.

Figure 2 Conceptual scope of the service (compiled based on the project working group discussions)



Classification of spatial units relevant for nature education service was developed on the basis of the correspondence to the following criteria: 1) area is used for educational purposes and 2) area is mappable based on existing map layers. The identified spatial units relevant for nature education service are shown in Table 2 and the activities that are related to the provisioning of nature education are displayed in Table 3.

[21] Fish et al. (2016)

Table 2 Spatial units relevant for nature education service

Spatial units that are relevant for provisioning nature education
SFMC recreational areas with study opportunities (three subclasses according to NATURA and protection level)
SFMC nature education program areas (three subclasses according to NATURA and protection level)
Nature education centers (three subclasses according to NATURA and protection level), Environmental Board
Nature education centers, other
Study trails; hiking routes with educational purpose
School gardens, parks; used for education
University study centers, field bases
Other nature (three subclasses according to NATURA and protection level)

SFMC (State Forest Management Center) recreational areas with study opportunities and SFMC nature education program areas were further subdivided into three subclasses in order to distinguish their educational potential according to their location on NATURA and other local protected areas. It is assumed that the potential education quality is higher in protected areas and lower in the areas that are not protected.

Table 3 Activities that are related to the provisioning of nature education in situ

Activities that are related to the provision on natural education *in situ*
Designing and delivering nature related curricula in nature
Creating study materials and learning environments
Nature trips
Outdoor school lessons
Providing specific skills
Providing expertise
Conducting research and creating knowledge

Evaluation of nature education spaces based on the potential educational values

If in general, the wider goal is to get the total monetary value of all relevant ecosystem services provided by any area, the approach for service valuation should be fully spatial. In order to get the spatial dimension, it is necessary to spatially valuate (model) the (potential) supply of the service and also the use of it.

Spatial units relevant for nature education service were assessed based on their potential educational values. Criteria for the assessment of the potential educational values of spatial units and the indicators for the quantification of the ecosystem education services on the basis of the reviewed literature (main input from Mocior & Kruse[22]) were analyzed and a set of criteria were agreed based on project group expert opinions. Table 4 outlines nature education values of spatial units relevant for nature education service and the assessment of importance. At first the relevance of the criteria of potential educational values was assessed on a three points scale by the project team. The assessment of agreed criteria is based on the current knowledge of the working group and should be treated as such. In our opinion ecosystem education values ask for a universal national level agreed criteria and assessment in future.

[22] Mocior & Kruse (2016).

Table 4 Criteria of nature education values of spatial units relevant for nature education service and the assessment of importance. Importance score: 2- precondition for provisioning of educational services; 1- important; 0- not important.

Criteria for the evaluation of the didactic value of nature sites	**Importance**
A. With regard to educational value	
1. Use for educational purposes	2
2. Availability of infrastructure for access	2
3. Supporting educational products and services (maps, information materials, printables, website)?	1
4. Existing learning infrastructure products (signposts, trails, boardwalks, information boards)	1
5. Approval for educational use	0
B. Criteria for defining scientific and didactic value:	
1. Rarity (ecosystem, landscape type), I, II and III category species' permanent habitat	1
2. Representativeness (ecosystem, landscape type), belongs to national parks, landscape protection areas	1
3. Diversity (the composition of different ecosystem types, species), national reserves	1
4. Level of scientific knowledge, monitoring sites	1
5. Useful for describing ecosystem processes	1
6. Paleogeographic value	0
7. Recognition	0
C: Criteria for other educational significance	
1. The protected area is part of major tours and routs	0
2. Recognition	0

On the basis of the used criteria, a matrix (Table 5) was compiled which outlines the values of the components of education service value to each spatial unit relevant for nature education service. The matrix could serve as a lookup table for potential capacity evaluation of nature education ecosystem service.

Table 5 Categorization of spatial units relevant for nature education service by the nature education value. (TBA- to be agreed)

Nature education provisioning sites /Dimension of educational value	Site specification	Educational products and services	Learning Infra-structure, products	Rarity	Representativeness	Diversity	Scientific knowledge	Ecosystem processes	Use rate
Scale		0-5	0-5	0-5	0-5	0-5	0-5	0-5	0-10
SFMC: recreational areas with study opportunities									
	Located fully on NATURA or other protected areas	5	3	4	4	4	3	4	10
	Located partially on NATURA or other protected areas	5	3	3	3	3	2	3	10
	Not located on NATURA or other protected areas	3	2	1	1	2	1	2	10
SFMC: nature education program areas									
	Located fully on NATURA or other protected areas	5	5	4	5	4	3	4	7
	Located partially on NATURA or other protected areas	4	5	3	4	3	2	3	7
	Not located on NATURA or other protected areas	3	5	1	2	2	1	2	7
Nature education centers, Environmental Board		5	4	4	4	3	3	4	6
Nature education centers, other		5	4	4	4	3	2	4	TBA
Hiking routes with educational purpose		3	3	3	3	3	1	3	TBA
School gardens, parks, used for education		2	4	3	3	2	1	4	TBA
Universities study centers field bases		4	4	4	4	5	5	5	TBA
Other nature									
	Located fully on NATURA or other protected areas	1	1	4	4	4	3	4	TBA
	Located partially on NATURA or other protected areas	1	1	3	3	3	2	3	TBA
	Not located on NATURA or other protected areas	0	0	1	1	1	1	2	TBA

TBA- to be agreed

Each spatial unit relevant for nature education service (which is receiving students) is categorized according to the type and valued according to the criteria.

The assessment of the total value of ecosystem services supplied by a spatial unit requires spatially relevant data. Estimation of the nature education ecosystem services *in situ* often

requires data about the number of people receiving nature education and the location of the sites where it is received. The quality valuation of ecosystems belonging to a certain “value classes” is relevant for quantification of the benefits of nature education.

In order to create the link between activities and spatial units relevant for nature education service, a survey and queries (of large data holders about available relevant data were performed.

Methods for the monetary valuation, based on time use, expenditures and stated preference, also approaches for spatial distribution of the results are described in the following chapters.

The indicators for the quantification of the ecosystem education services have been decided to be “the number of hours spent on nature education”, “the number of hours spent in direct contact with the ecosystem”, “number of participants in nature programs”, “expenditures made for provisioning nature education”, “expenditures made for receiving nature education”.

The further refinement of the proposed approach is the subject of discussions.

Nature education as ecosystem service, data sources and survey

In Estonia there are two kinds of providers of nature education in Estonia. First, there are the owners (managers) of the nature education sites/nature tracks and secondly there are nature education service providers who do not manage nature objects.

State Forest Management Center is the largest and Environmental Board is the second largest provider of nature education service, but there are also some smaller providers. The databases of State Forest Management Center and Environmental Board were obtained by separate inquiries and analyzed together with their experts.

For smaller scale service providers, three separate questionnaire types were designed depending on the activities and characteristics of the different companies and institutions: whether these were nature/environmental education service providers or managers of some natural object(s) in addition. The destinations, visitors numbers, share of time in direct contact with ecosystem and the expenditures on delivering nature education programs were asked in the surveys. For the final database the destinations were georeferenced. The overlap will be dealt separately in order to avoid double counting.

The spatially informed database about the provisioning of nature education could be further refined and used in future work.

Data collected during the survey is shown in Table 6. Names of the used/ managed/ visited/ nature education trails and sites were collected in order to possibly determine the coordinates of these trails and sites.

Table 6 Sources for the data about nature sites/objects

	Expenditures for the maintenance of nature education sites/tracks	Revenue from/expenditure for the provisioning of the nature education	Number of lessons given	Number of students	Time spent on nature studies directly in ecosystems	GIS data
Owners of the nature education sites/nature tracks:						
State forest Management Center	Bookkeeping data	Admin data	Admin data	Admin data	Admin data	Received map layer
Environmental Board	Admin data	Admin data	Admin data	Admin data	Admin data	Manually allocated
Others	Survey data	Survey data	Survey data	Survey data	Survey data	Manually allocated
Service providers who do not manage nature objects	not relevant	Survey data /imputed/ extrapolated	Survey data /imputed/ extrapolated	Survey data	Survey data	Manually allocated

Some of the service providers conduct their nature education programs only in one certain nature trail or site, some of them use several, some visit sites all over Estonia and some deliver nature education programs where the client wishes. It is worth mentioning that these service providers quite often use the infrastructure provided by State Forest Management Centre.

Hence, in order to avoid overlapping, we wanted to clarify the use of the infrastructure of State Forest Management Centre in the delivering of nature education programs by service providers.

The State Forest Management Centre (corporation, belonging to non-financial corporation sector) is the largest provider of nature education, managing four nature houses, 14 nature centers, nature school Sagadi Forest Centre, and Sagadi Forest Museum. Recreation and protection areas of State Forest Management Centre were visited in total 2.7 million times (51 000 nature education related visits) in 2018. The State Forest Management Centre website www.loodusegakoos.ee was visited over four million times in 2018. The State Forest Management Centre used a total of six million euros in 2018 to administer the visitor management infrastructure, preserve its state and organize activities promoting environmental awareness; 1.5 million of it was received as target financing from the European structural funds and was used to reconstruct the visitor management infrastructure of the protected areas. The share of nature education has been estimated to be 10% from the total recreation related expenditures.

The analysis of the received data from nature education service providers was performed and the overview of the results is shown in Table 7.

Table 7 Distribution of providers of nature education service between market and non-market producers, number

	Market (S11, S14)	Non-market (S13, S15)	Other	Total
Owners of the nature education sites/nature tracks:		9	1	10
State forest Management Center			1	1
Environmental Board		1		1
Others		8		8
Service providers who do not manage nature objects	8	27		35
	8	**36**	**1**	**45**

Current expenditures (mainly on educational programs and facilities), made by those who offer nature education service and own a nature area, where education programs are held were collected with a survey.

We also surveyed and explored the sales revenue from offering nature education service of the companies that supply nature education service and do not manage a nature object. Sales revenue was specifically asked because it was considered more accurately to reflect their environmental activity as they do not have current expenditures on managing nature objects. Subsidies and grants handed out by Center for Environmental Investments were also considered in order to get more information on the nature education provided by companies and ensure the quality of our results. Total current expenditures and revenue made by public and private service providers are shown in Table 8. Also, an attempt was made to get missing data from business reports if the survey was not filled.

Table 8 Providers of nature education service and expenditures made (thousand euros)

	Market (S11, S14)	Non-market (S13, S15)	Other	Total
Owners of the nature education sites/nature tracks:		550	1 182	1 732
State forest Management Center			1 182	1 182
Environmental Board		41		41
Others		508		508
Service providers without nature objects	9	226		236
	9	**776**	**1 182**	**1 968**

Nature education as ecosystem service: valuation

The theoretical overview of the relevant methods is described in chapter "Overview of the relevant studies and concepts for defining and valuation nature education service provided by ecosystems". In current chapter the following tested approaches are described:

1. expenditure transfer approach
2. expenditure based approach
3. travel cost approach
4. contingent valuation study: willingness to pay (WTP) for ecosystem services of Estonian grasslands

Future benefit (avoided cost) and time use based approach methods are discussed as well but the calculations were not performed.

The results from different applied methods were compared and the model Supply-Use table was compiled.

Expenditure transfer approach

Finding the monetary value of ecosystem education services through institutional education spending is based on the assumption that general education is a public service aimed to creating and improving the quantity and quality of human capital. The measure of the value of education is thus an increase in human capital through education, which, however, is difficult to express in monetary terms. Given that the vast majority of education is free of charge to consumers, it can be classified as a non-market public good, whose monetary equivalent can be obtained by using non-market valuation techniques. One such is the incurred expenditure method, which is an indirect method of economic valuation of non-market goods and values. According to this approach, the monetary value of education is considered proportional to the cost to society of providing education. The disadvantage of the method is that the value of education calculated this way is very likely to be lower than the value of human capital created by education. The strength of this method is that it is based on actual costs, which are well described in official statistics.

The method described above can also be used to evaluate the monetary value of both nature education and ecosystem nature education services. Available data allows the total cost of institutional education to be attributed to the ecosystem through its share of hours in contact with the ecosystem. An important assumption for this approach is that the nature program trips should already be included in the official study programs so that time spent in direct contact with the ecosystem would make up one share of the total appointed curriculum of nature subjects in school. Our study does not fill this assumption very well as our data about nature trips was collected as an extracurricular or hobby school activities.

However, this caveat in mind, calculations were still made by applying the method to estimate the nature education service value of Estonian ecosystems by the total cost of hours of being in direct contact with the ecosystem. According to the expenditure transfer approach, the financial equivalent of nature education service value of Estonian ecosystems is **approximately EUR 5.12 million per year**. It was calculated as follows:

$$Nature\ education\ service\ value = a * b * c$$

where a - average time spent on nature studies directly in ecosystems (h);
b – number of students in nature education programs;
c – cost of one student hour, €. Calculated based on public expenditure on institutional education per year, number of students in institutional education (all levels considered) and average total number of lessons per student per year.

Parameter	**Value**
a - average time spent on nature studies directly in ecosystems (h);	5
b – number of students in nature education programs	116989
c – cost of one student hour (€). Calculated based on public expenditure on institutional education per year, number of students in institutional education (all levels considered) and average total number of lessons per student per year	8.75= =1300000000/(220000*675)

The calculations are made based on preliminary data and will be refined for the final project report.

Given that the number of hours of nature education at the site has been determined, the total cost ascertained can be related to specific nature site based on visitor hours at the location. The value of education service for different ecosystem types present within the nature site can be divided by their proportion and also per hectare.

Expenditure based approach

Second expenditure based method for valuing nature education as an ecosystem service, considers also (as the method described in previous chapter) that expenditures made to provide nature education service reflect the value that society is ascribing to the service. The expenditures of those providing the nature education service are considered as the value of service. Assumption was made that the sales revenues cover at least the expenditures made.

We also considered SEEA EEA guidelines regarding the SNA approaches to valuing non-monetary transactions (p 5.4.3). UN SEEA EEA suggest that if market prices are not observable, valuation according to market price equivalents should provide an approximation to market prices. In such cases, market prices of the same or similar items when such prices exist will provide a good basis for applying the principle of market prices, provided the items are traded currently in sufficient numbers and in similar circumstances. This option is not relevant for educational service of the ecosystems. Where no sufficiently equivalent market exists and reliable surrogate prices cannot be observed, the SNA identifies a second-best procedure for use, namely, the cost of production approach (p 5.45), in which the value of the non-monetary transaction is deemed to be equal to the sum of the costs of producing the good or service, that is, the sum of intermediate consumption, compensation of employees, consumption of fixed capital (depreciation), other taxes (less subsidies) on production, and a net return on capital (2008 SNA, para. 6.125).

Discussions with the experts have revealed that considering the whole expenditure as ecosystem input is questionable, as it would represent the economic input to the production of the service (incidentally, although the ecosystem does 'provide' or supply the services). It has been also decided that it is important to distinguish the costs of the maintenance of nature education areas and providing facilities and the expenditures on service provision (specialized producers without the "real estate"). We have the following expenditures data (Table 9) which reflect in some way the value that society is putting on the educational experience. However, we have the opinion that this method does not allow to single out the part of the ecosystem input as there are just the expenses made by society and only a profit could be attributed to the ecosystem. Expenditure based approach has conceptual similarity with other "indirect i.e. transaction based" methods (like travel cost approach) where one could attribute the residual component as a share of the ecosystem.

Table 9 Expenditures on nature education provision by categories, 2018, million EUR

	Expenditures on nature education service, calculated on the basis of sales revenue and other income	Current expenditures on educational programs and facilities	Value of ecosystem nature education service
Non-market service providers (owners of nature objects)		0.55	0.55
Non-market service providers (not owning the nature objects)	0.26		0.26
State Forest Management Center, market service provider but providing free nature education service		0.78	0.78
Other market service providers	0.02		0.02
Total	0.28	1.33	**1.61**

In order to calculate the total value of nature education service current expenditures, sales revenues and other incomes for supporting service providers were aggregated. Overlapping expenditure data was excluded as data taken into calculations was a) the current expenditures of service providers that own/manage nature sites, b) sales revenue and other income of service providers that use but do not own the sites. Total value of ecosystem nature education service in 2018 was ca 2 million euros if to consider the expenditures of the providers of nature education service.

UN SEEA recommends decomposition of a market price into components and assumes that the costs of production include a normal return on capital as a common approach to value the production of education and health services (5.46). This option was considered relevant for educational service of the ecosystems. In case of market service-providers we can identify profit and theoretically attribute this to ecosystems then in case of non-market service providers this approach cannot be directly applied as non-market service providers do not receive profit from their activity. We assumed that the ecosystem contribution would be the same for market and non-market service providers and in order to determine contributions of ecosystem we decided to use the structure from market service providers. Average profit was calculated on the basis of available profit and sales revenue of companies who offer nature education service. Using available data, it was calculated that average profit was 17%. If to apply this share to the value of the service calculated by expenditure method for non-market producers as well, then ecosystem contribution would be 0.3 million EUR.

The expenditures are linked to the georeferenced locations in our database. Based on georeferenced locations we map the specific expenditures with related location to get nature education service value map.

Time use based approach

In a discussion paper on recreation services compiled by David N. Barton and Carl Obst[23] time-use is described as a welfare value based monetary valuation approach. Time spent on an activity in a greenspace can be considered a good measurable indicator of the benefit generated by the service to the welfare of the recipient. However, the monetary value of time spent onsite on an activity is highly context specific and many assumptions need to be made to apply this method. One of the most significant being that it assumes that the alternative to the activity is work paid by the hour.

In our case, where the service is nature education and according to collected data, the recipients are mostly students in different levels of compulsory education. Therefore, it is not appropriate to apply this time use based method as the assumption of work paid by the hour does not stand considering that there is no legal alternative for time spent for studying for students. To try out this method, one might consider using other equivalent for expressing of students' time value in calculations, like present value of future salary.

It is also debatable how well the time spent on site (receiving education about the surrounding ecosystems) can describe the welfare derived from the activity at large, i.e. the real value of the contribution of ecosystems.

Travel cost approach

The travel cost model is usually used to value recreational uses of the environment. The model is commonly applied in benefit cost analyses and in natural resource damage assessments where recreation values play a role (Champ, et al 2003)[24]. The travel cost model is a demand based model for expressing a demand for recreational site or sites. Although the demand for a site can be modelled as an aggregate or market demand, the common practice is to estimate demand function on the level of the individual and to calculate site values by adding up individuals` values for the site (Myrick Freeman III, 2003)[25].

Although the travel cost based approach has been developed specifically to measure recreational value, our study attempts to use it to assess the educational value of the ecosystems. This is possible because visiting ecosystems for educational purposes also involves travel costs.

It is important to note that in this work, the estimation of ecosystem education service based on travel costs is not a classic application of the travel cost method. Although actual travel costs are used to determine the monetary value of an ecosystem service, the approach used is not based on individual`s demand and the demand curve constructed on that basis.

[23] Barton, D.N., Obst, C. Discussion paper #10 Recreation services. SEEA Experimental Ecosystem Accounting: Revision 2020. Research papers on Individual Ecosystem Services. Version 7.1 17th December 2018

[24] Champ, P., Boyle, K., Brown, T (eds.). A Primer on Nonmarket Valuation. Kluwer Academic Publishers, 2003

[25] Freeman. A. M. III. The Measurement of Environmental and Resource values. Theory and Methods. 2nd ed. Washington, DC, 2003.

According to the methodology, trip cost is the sum of expenses required to make a trip possible. Typical trip cost includes: travel cost, access fees, equipment cost and time cost (Champ, et al 2003).

In order to provide nature education in contact with the ecosystem, students usually travel by bus. The difference from the classical application of the method lies in the fact that the trip is not paid by the students but by the tour organizer, which is either a school or a hobby school (usually method uses individual expenditures). Typically, there are no access fees and equipment costs for any such trips. It is also debatable to use time costs calculations for students because they have no income. Thus, travel expenses for students for educational purposes are the bus rental cost, typically paid by the tour organizer.

In Estonia, the cost of renting a bus suitable for student transportation depends on the duration of rental and not on the distance travelled. The total annual travel cost of providing institutional nature education in Estonia is **EUR 2,024 million**. It was calculated as follows:

$$Nature\ education\ service\ value = a * b$$

where a - average travel costs for one student (€);
b – number of students in nature education programs.

Parameter	Value
a – average travel costs for one student (€). Calculated based on average bus rental price (43,25 €/h), average rental duration (8 h), typical student group size (20)	17.3= =43.25*8/20
b – number of students in nature education programs	116989

The calculations are made based on preliminary data and will be refined for the final project report.

A separate question is what proportion of the total travel costs should be attributed to the ecosystem. One possible approach is to attribute the profit margin of the transportation sector to entire travel costs and consider that as a share of the ecosystem.

According to Estonian statistics (table reference in Statistics Estonia database RAA0043), the profit margin in the field of transporting and storage activities in supply and use tables is 3.548%. With this approach:

2.024 million EUR x 3.548% = **0.072 million EUR can be attributed to the ecosystems**

Undoubtedly, the value of the ecosystem education service derived from the carrier's profits is modest and is likely to be underestimated. It was assumed that the profits generated by occasional bus services are higher than the group average in the statistics. The profits generated by occasional bus services were assumed to be around 15% by the expert opinion. With this approach:

2.024 million EUR x 15% = **0.304 million EUR can be attributed to the ecosystem**.

In any case, the transfer of the monetary value found using travel cost based approach to the ecosystem needs further discussion.

The visitation rates are linked to the georeferenced locations in our database. To get nature education service value map we allocate travel costs to destination locations by their visitation rates.

Contingent valuation study: willingness to pay (WTP) for ecosystem services of Estonian grasslands

Contingent valuation (CV) method relies in interviewing the members of a representative sample (in this study, the working-age population of Estonia) about their willingness to pay for the non-market environmental goods that are being studied. Before answering the questions about their willingness to pay, the respondent must be given adequate information about the values for which their willingness to pay is measured. In addition to the willingness to pay, the respondent is also interviewed about their sociometric indicators.

A contingent valuation survey was conducted in 2019 to find out willingness to pay (WTP) for ecosystem services of Estonian grasslands. The CV questionnaire included a simulated market scenario, guidance questions, a WTP question and a sociometric section. An open end WTP question was: "I agree to pay … euros per year for maintaining Estonian grasslands." The sample size was 414 respondents and the sociometric structure of the sample corresponded to the adult population in Estonia.

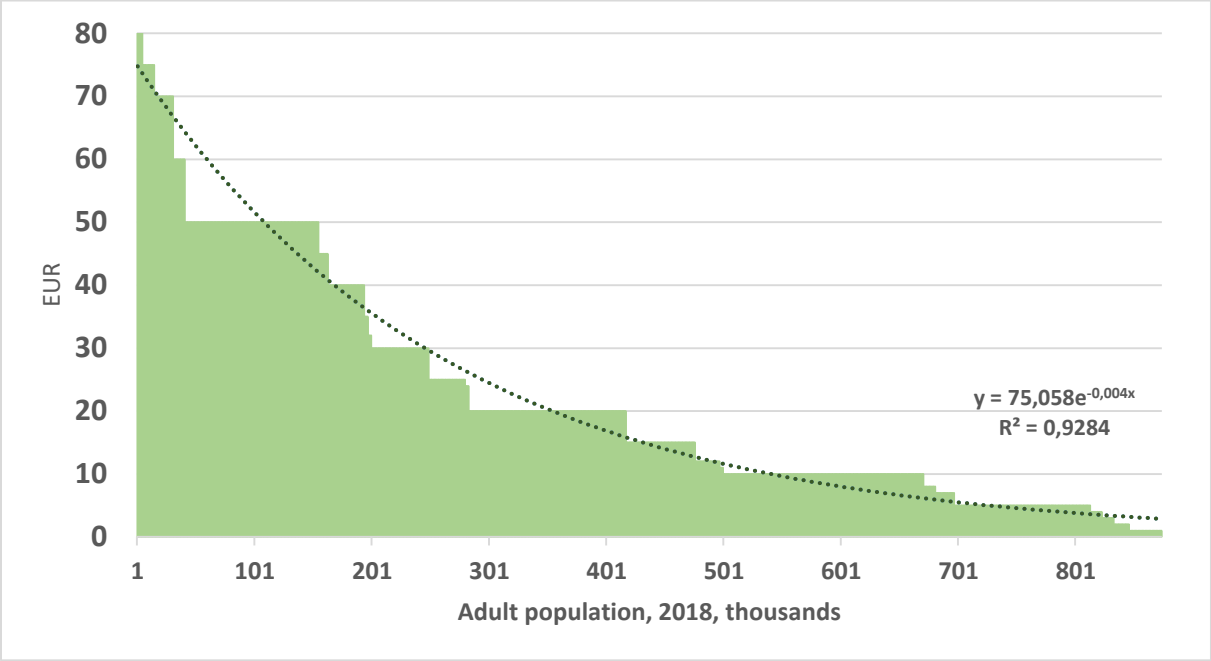
Based on the answers obtained, the demand curve was constructed which served as a basis for for determining total WTP (Figure 3).

Total demand for Ecosystem services of Estonian grasslands is obtained by integrating the demand curve (Figure 3). The aggregate demand is found by integrating the demand curve in the figure according to the formula:

$$CS = \int_{x_1}^{x_2} WTP(x)dx = \int_{x_1}^{x_2} \alpha e^{-\beta x} dx = -\frac{\alpha}{\beta}(e^{-\beta x_2} - e^{-\beta x_1}) \cong \frac{\alpha}{\beta} \quad ,$$

where x_1 is 0 and x_2 denotes the number of people with positive willingness to pay.

Figure 3 Total willingness to pay for ecosystem services provided by Estonian grasslands per year.



$WTP=\alpha e^{-\beta x}$

$WTP=75.058e^{-0,004x}$

$WTP_T = \alpha/\beta = 75.058/0.004 = 18\ 764.5$ thousand €

Adult population of Estonia (01.01.2018) is 1 070 375

Per cent of respondents with positive willingness to pay in the sample is 81.64

Population of Estonia with positive WTP (extrapolated) is 873 881

Number of respondents with a positive WP is 338

Corresponding population is (thousand) 874

1 answer equals to 2.6 thousand adults

Total annual WTP of Estonian adult population for ecosystem services provided by Estonian grasslands is 18.76 million euros. In addition, respondents were asked to rank different ecosystem services in order of importance using 10 points Likert scale (1-the most important).

Based on the quantified preference given to ecosystem services, total WTP can be divided between individual services (Table 10, WTP (thousand EUR)).

Table 10 WTP distributed between ecosystem services ordered by importance according to preferences

Ecosystem service	Average score in Likert scale	Total points received	%	WTP (thousand EUR)
Habitat conservation for biological species	3.72	1258	13.9	2610.7
Climate control	4.80	1622	10.8	2024.8
Photosynthesis (production of oxygen)	4.88	1651	10.6	1989.2
Ensuring landscape diversity	5.16	1740	10.1	1887.5
Maintaining soil fertility	5.18	1751	10.0	1875.6
Provision of genetic and medical resources	6.27	2118	8.3	1550.6
Enabling pollination and honey harvesting	6.31	2134	8.2	1539.0
Supply of agricultural produce	6.81	2302	7.6	1426.7
Flood protection	6.99	2364	7.4	1389.3
Enabling nature education	**7.64**	**2583**	**6.8**	**1271.5**
Provision of tourism and leisure services	8.10	2738	6.4	1199.5
TOTAL		22 261	100.0	18764.4

According to the data in Table 10, the service is in the penultimate position among all ecosystem services provided by Estonian grasslands. Considering respondents' preferences, 6.8 percent of the total aggregated WTP can be attributed to the service "enabling nature education".

Thus, the annual WTP for the ecosystem service "enabling nature education" provided by Estonian grasslands is 1.271 million euros. According to the contingent valuation methodology, this can be considered as the annual monetary equivalent of the ecosystem value.

The WTP study and calculations were carried out only for Estonian grasslands. For the sake of comparability (as the other methods considered all ecosystems), we have made a rough estimation of the nature education service value regarding other services and describe this in the chapter "Nature education as ecosystem service: spatial dimension".

We can map the nature education service value for grasslands estimated by WTP method by the potential educational value of the nature site (Table 5 Categorization of spatial units relevant for nature education service by the nature education value).

Discussion of future benefit and avoided costs concepts in the context of nature education service

The aim of nature education is to grow the understanding of ecological systems and eventually to contribute to environmental improvements in the future. So, the service of nature education should in principle be valued also by avoidance cost method. However, the magnitude and cost of the future damages are currently not measurable.

Another theoretical concept what seems to be desirable is the contribution of nature education to the future benefit or income. Also, technical recommendation touches upon it and gives the example from education economics (Chapter valuation 6. 22, 6.23). We know that according

to CICES V5.1 definition[26] the main purpose of nature education is to "prevent the loss of the landscape characteristics and biodiversity of species" i.e. to avoid the degradation of the ecosystems. So, in principle capturing the future value of nature education in monetary terms seems to be relevant. Expert group has been discussing the issue and concluded that monetary expression of future ecological value related to nature education seems highly complicated, as even the concept of present value of education is not unanimously agreed.

We do not know if this approach (calculation of the future ecological value related to nature education) has been used for the valuation of education ecosystem service. In education economics the key questions is for example, how much the investments in education would bring back as a surplus in future. What could be the analogue for nature education?

Experts' opinion has been that counting our spending to understand the functioning of ecosystems better as a contribution of the ecosystem to society is somewhat circular akin to other spending on ecosystem maintenance and restoration. Separately they note that secondary benefits are not generally included in the valuations according to SNA (e.g. the future benefits from education are not generally recorded as the value of the education service in the National Accounts). This issue was also referred to relation to the future education benefits derived from improved health, in one of the SEEA EEA revision research papers on the topic of ecosystem services[27].

Experts thought was that it might be worthy to discuss the replacement costs, but this would need more consideration.

UK National Statistical Office (ONS) is looking at using the value of the learning potential from degrees in ecology etc. It could be worth reviewing this approach in the future as well. Still the question remains what is the contribution of the ecosystem to the educational benefit here, if the purpose is studying the ecosystem.

Integration of nature education as ecosystem service in supply and use tables

In order to integrate the values of ecosystem services with national accounts, an attempt was made to add the results to extended supply-use tables using the same structure as is used in national accounts. Supply table includes sectors that offer services and goods. To integrate the table with ecosystem contributions it was necessary to add ecosystems as a supplying sector in addition to corporations, general government and NPISH (nonprofit institutions serving households). Use table includes data of using services and goods. As the main user of nature education is the households then all the final use of educational service was allocated to them. All the aggregate values of nature education service calculated by selected methods used during this study are shown in table 11.

[26] Haines-Young ja Potschin (2018)

[27] Harris, R. 2019. SEEA Experimental Ecosystem Accounting: Revision 2020. Research paper on air filtration ecosystem services

Table 11 Supply of nature education service by calculation methods and suppliers, 2018 (million EUR)

	Service supply = Final use of the service by households	Total supply	
		Supply of economic sectors	Supply of ecosystems
Expenditure transfer approach	**5.12**	**Not relevant**	5.12
Expenditure based approach	**1.57**	1.30	0.27
Travel cost based approach	**2.02**	1.72	0.30
Contingent valuation method (covers only grasslands, ~6% Estonian ecosystems area)	**1.27**	**Not relevant**	1.27

For some of the methods (expenditure based and travel cost based approach) it was possible to distinguish contribution of the ecosystems separately but not for all. In the latter case the whole service value was attributed to ecosystems. The more detailed supply and use table following the logic (SEEA EEA TR table 8.1., page 132) of nature education service and the results of methods calculated during the study can be seen in Table 12 and Annex 2. The supply and use of nature education service (thousand EUR).

Table 12 The supply and use of nature education service (million EUR), 2018

	Eco-systems	Corporations						General government			NPISH	Final consumption of households	Total
		A.02	H.49	L.68	M.74_75	P.85	R.93	O.84	P.85	R.90_91	S.94		
Expenditure transfer approach													
Supply													**5.12**
Ecosystem service - nature	5.12												5.12
Nature education													
Use													**5.12**
Ecosystem service - nature													
Nature education												5.12	5.12
Value added (supply-use)	**5.12**												**5.12**
Expenditure based approach													
Supply													**1.57**
Ecosystem service - nature	0.27												0.27
Nature education		0.65		0.00	0.00	0.00	0.00	0.03	0.07	0.41	0.13		1.30
Use													**1.57**
Ecosystem service - nature		0.21		0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.01		0.27
Nature education												1.3	1.30
Value added (supply-use)	**0.27**	**0.44**		**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.06**	**0.37**	**0.12**		**1.30**
Travel cost based approach													
Supply													**2.02**
Ecosystem service - nature	0.30												0.30
Nature education			1.72										1.72
Use													**2.02**
Ecosystem service - nature			0.30										0.30
Nature education												1.72	1.72
Value added (supply-use)	**0.30**		**1.42**										**1.72**
Willingness to pay method													
Supply													**1.27**
Ecosystem service - nature	1.27												1.27
Nature education													
Use													**1.27**
Ecosystem service - nature												1.27	1.27
Nature education													
Value added (supply-use)	**1.27**												**1.27**

First section “Expenditure transfer approach” includes values calculated with expenditure transfer approach where the whole supply is attributed to ecosystems because it was not possible to separate ecosystems and economic sectors. Users are students who belong to household sector. Adding ecosystem as a supplier expands supply, use and value added as supply of the service cannot yet be separated in SNA (it is not supplied by economic sectors). Actually in this method value added should expand only as much as not covered by government and households funding. This has not been possible to separate. So, the whole value was attributed to ecosystem and therefore also value added expands proportionally.

Second part “Expenditure based approach” includes values calculated with expenditure based method. Nature education service providers are ecosystems and various economic sectors that belong to different NACE activities. In use part of table ecosystem contribution (0.27) is divided between all economic activities that use ecosystem service to provide their services (it was assumed that most of them use 10% and the largest supplier balanced the supply and use). Final users are households. Table shows that total value added is smaller than supply and use. It is because ecosystem contribution does not expand value added but divides already made and accounted value added (1.3) between economic industries (1.03) and ecosystem (0.27). Industries use ecosystem educational service as an input to supply nature education service. As the supply and use of the service is already included in SNA (economic industries supply the service) then the value added cannot be larger. This section shows the part of industries value added which comes from ecosystems (0.27).

Third section “Travel cost based approach” includes values calculated using travel cost based approach where suppliers are ecosystems and transport sector. Users are transport sector that use ecosystem service to provide their service and households. The logic in this section is the same as was in expenditure based method – supply (2.03) and use (2.03) are larger than value added (1.73) because already accounted value added is distributed between ecosystem and transport activity. It is seen that a part of transport sectors value added actually comes from ecosystems (0.30).

Fourth part “Willingness to pay method” includes values calculated with willingness to pay method where suppliers are ecosystems and users are households. In this section also total value added expands (1.27) because the service value calculated (supply 1,27, use 1,27) with willingness to pay method is not accounted in SNA and is an addition to already included values.

Spatial distribution of nature education service

In order to explore spatial distribution of ecosystem services and estimate the provisioning of relevant ecosystem services per ecosystem asset, a necessary step is to take a fully spatial approach. Each of the georeferenced sites which provides at least some level of ecosystem education service (receiving the students), are categorized according to the type of the site and the correspondence to the value of the criteria which are shown in Table 5 Categorization of spatial units relevant for nature education service by the nature education value.

For the creation of spatially informed database to estimate the provision of nature education per ecosystem asset, several GIS layers will be used: spatial data of the educational areas of State Forest management center, data of Natura 2000 protected areas network and data for local protected areas which are outside of Natura 2000 network. Additional GIS layer will be created for the areas used for nature education: nature education centers of Environmental Board, other nature education centers, hiking routes with educational components, school gardens, parks used for education, universities study centers and field bases.

Calculated nature education ecosystem service values can be mapped by the method (approach) -relevant indicator that is linked to the georeferenced locations in our database. The value of education service for different ecosystem types present within the nature site can be divided by their proportion and also per hectare. We will map nature education ecosystem service values spatially across Estonian ecosystems using ecosystems map (in development this year) and different GIS tools. As our current grant focuses on grasslands, we will derive annual education service values related to grasslands which is narrower focus of our current grant. We will supplement our ecosystem map with collected data from visitors monitoring and study trips, which was our primary data for educational visits.

Nature education as ecosystem service, analyses of the applied valuation methods and a comparison

The criteria for the evaluation were selected to highlight various methodological aspects and also allow to value the consistency of methods with the recommendations of UN SEEA EEA. Criteria are partly based on those, described and applied in a "Valuation method selection criteria – a proposal. Working Paper for discussion at Forum of Experts on SEEA Experimental Ecosystem Accounting 2018 11 June 2018" by David Barton[28]. In addition the developments of these criteria in discussion paper 5.1 "Defining exchange and welfare values, articulating institutional arrangements and establishing the valuation context for ecosystem accounting" prepared by the experts as part of the work on the SEEA EEA Revision coordinated by the United Nations Statistics Division, was considered. Table 13 below provides an insight to the evaluation of the used methods.

[28] Barton, D.N., 2018. Valuation method selection criteria – a proposal. Working Paper for discussion at Forum of Experts on SEEA Experimental Ecosystem Accounting 2018 11 June 2018. https://seea.un.org/sites/seea.un.org/files/documents/Forum_2018/seea_eea_expert_forum_2018_-_discussion_paper_on_valuation_paper_2.pdf

Table 13 Adequacy of the methods for valuation of nature education ecosystem service, correspondence to criteria

Method/criteria	**Expenditure transfer approach**	**Expenditure based approach**	**Contingent valuation**	**Travel cost approach**	**Time use based approach**
Description	Education costs are attributed to the ecosystems (on the bases of hourly lesson prices)	Expenditures to provide nature education are calculated and ecosystems contribution is found	Willingness to pay for education service	Students travel costs are attributed to the ecosystem	Value of the time spent in contact with ecosystem studying is attributed to the ecosystem
Conceptual consistency	Low, two-step assumption	High, based on real expenditures	High, classical application	Low, non-classical application	Low
Production boundary					
How well is it reflected in SNA, 5.1. tabel 1.1 yes/no	yes	Yes	no	yes	No
How well is it reflected in SNA, channels according to Doc 5.1. figure 1.1	2	1,2	4	3	4
Double counting in sense of service value (Does this identification reduce the likelihood of double counting?)	Probable double counting of educational public expenditures	Not relevant	Not relevant	Not relevant	Not relevant
Routine production	no	No	no	no	No
Need for extra study	yes	Yes	yes	yes	Yes
Institutional compatibility (are the assumptions used the same as for institutions governing ecosystem service use)	no	Yes	no	maybe	No
Is the method vulnerable to zero or low monetary values? (relative to level of biophysical flows), Significance	Yes, as it depends on government funding	Yes, as it depends on government funding	Yes, as WTP depends on welfare	yes	Yes, as students do not have salary
Robustness (Is the valuation method complex, subject to a large number of data transformations and modelling assumptions? (methods with few data transformation steps and assumptions are more robust)	Low, as there is a two level assumption	High-medium, quite straightforward	High, if applied properly	Medium-low, as several assumptions involved	N/A
Accuracy	Depends on the response rate	Depends on the response rate	Depends on the sample size and quality	Depends on the response rate	No, students time value is not known and it is indirectly linked to ecosystems
Technical complexity	Yes. GIS-analysis	Yes. GIS-analysis	Yes. GIS-analysis Special software	Yes. GIS-analysis	N/A
Information cost	Yes, depends how often additional study is carried out	Yes, depends how often additional study is carried out	yes	Yes, depends how often additional study is carried out	Yes, depends how often additional study is carried out
Other policy applications	No	No	No	No	No
Computational demand (table 4.1)	High, when to consider GIS-analysis.	High, when to consider GIS-analysis.	High, econometric analyses; GIS-analysis	High, when to consider GIS-analysis.	N/A
Challenges	Can public expenditures per education unit be used to calculate the education service value of ecosystems?	Is it right to attribute the profit of nature education service to ecosystems? Or count all expenditures made as ecosystem service?	Linking stated preferences to SNA.	Which part of the transportation costs can be attributed to ecosystems, profit?	What can be used as equivalent for expressing students' time value in calculations?

In the classification of ecosystem services, education service is regarded as cultural service (CICES V5.1)[29]. This determines the nature of education services and the choice of methods for economic evaluation of ecosystem education services.

An educational service is one of the non-market services that does not produce a market product and therefore the monetary value of which should in principal be assessed by the revealed preferences or stated preferences associated with the service.

Unlike recreational ecosystem service similar to educational ecosystem service, the distinctive feature of educational services is that the financial costs of providing an educational service are relatively well defined and can be expressed as a specific amount of money. This is valid both to public education expenditure and to investments into nature education infrastructure in sites where the learning process takes place in contact with ecosystems. This makes it possible to use the expenditure transfer approach although part of the expenditure on education is attributable to the ecosystem. This method requires data about expenditures made for education and defining the role of the ecosystem in providing nature education. The role of the ecosystem in providing nature education can be evaluated in several ways. In current study, in some cases the ecosystem component is taken as a proportion to the number of lessons that take place in direct contact with the ecosystem.

This approach has been applied to the expenditure transfer approach, where public sector expenditures on lessons are attributed to the ecosystem according to the actual lessons taking place in contact with the ecosystem. The advantage of the method is that the educational value of the ecosystem is based on the actual expenditure on education and the number of student hours actually spent in the ecosystem. The disadvantage of the method is that the concept is speculative and based on the assumption that the educational value of the ecosystem is expressed through contact hours.

The second method, the expenditure based approach, is based on the cost of actual expenditures made to provide nature education in the ecosystem. Its strengths are that it is based on actual expenditures, the direct link between expenditure and nature education, and the possibility of linking expenditure to specific locations. The disadvantage is that this approach does not take into account other nature education expenditures (such as transport costs, labour costs) and should be combined with other methods to find out the total value of ecosystem as a provider of nature education (as there are other costs to be considered such as household expenditures). The advantage of both cost-based methods from the accounting point of view is that the value attributed to ecosystems is included in the SNA and the application of the methods does not require extensive specific research.

The travel cost based approach, which has also been applied in this work to find the financial equivalent of the educational value of the ecosystem, is also based on actual expenditures. This method is widely used in the economic valuation of non-market values of nature. Classically implemented, the method is based on individuals' travel expenses, which are used to construct a demand curve for ecosystem service and to calculate aggregate demand. In our case there is

[29] Haines-Young, R. and M.B. Potschin (2018):Common International Classification ofEcosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure. Available from www.cices.eu

a deviation from theory in evaluating an ecosystem education service using the travel costs, as students who visit ecosystems for educational purposes do not make individual expenditures, but the trips is financed by the school or sponsor. It is also a question of what proportion of travel costs can be attributed to the educational value of the ecosystem. For example, it is not clear if it is relevant to apply the concept that the educational value of the ecosystem equals to the profit of the carrier company, as carriers may be subsidized in Estonia. This method has the advantage of taking account of the actual costs and the possibility to allocate costs to specific locations.

The nature education service values found using three methods belonging to the group of revealed preferences mostly do not overlap. When double counting can be eliminated, then in principle consideration may be given to sum them up in order to determine the total value of the nature education service. While summing up the values received by different methods one still has to consider that two expenditure methods may overlap regarding some expenditures made by general government. Also overlapping is difficult to detect as the calculation logic of methods differ.

The fourth method used in this study was contingent valuation method (CVM), which is a stated preference method and is very widely used in estimating the non-market values of nature. The strength of the method is that it measures the welfare that ecosystem services provide to individuals. The disadvantage of the method is the poor relation to SNA and real turnover, which currently makes the integration of the values found by this method difficult with environmental accounting. The implementation of the method also requires considerable costs. However, CVM is the only method that measures the impact of the educational value of an ecosystem on well-being, so it measures value precisely according to the concept of welfare economics, whereby everything that positively affects well-being has value.

Another theoretical option for estimating the nature education service value of an ecosystem based on the price of time is not well applicable, since pricing a student's time is questionable unlike the wage earner's.

Conclusions

Development of the nature education ecosystem service methodology and application is carried out as a one part of the work under the Eurostat grant in a frame of knowledge innovation project on an integrated system for natural capital and ecosystem services accounting[30] in Estonia in 2019. The scope and the definition of the nature education service were formulated. The typology for the educational nature sites was developed. The criteria and potential values of the ecosystems educational values were agreed and valuated. Four different valuation methods were applied and the results were compared, implemented in the supply and use table format and discussed.

Methodological issues were highlighted and proposed for the discussion for the London group.

[30] http://ec.europa.eu/environment/nature/capital_accounting/index_en.htm

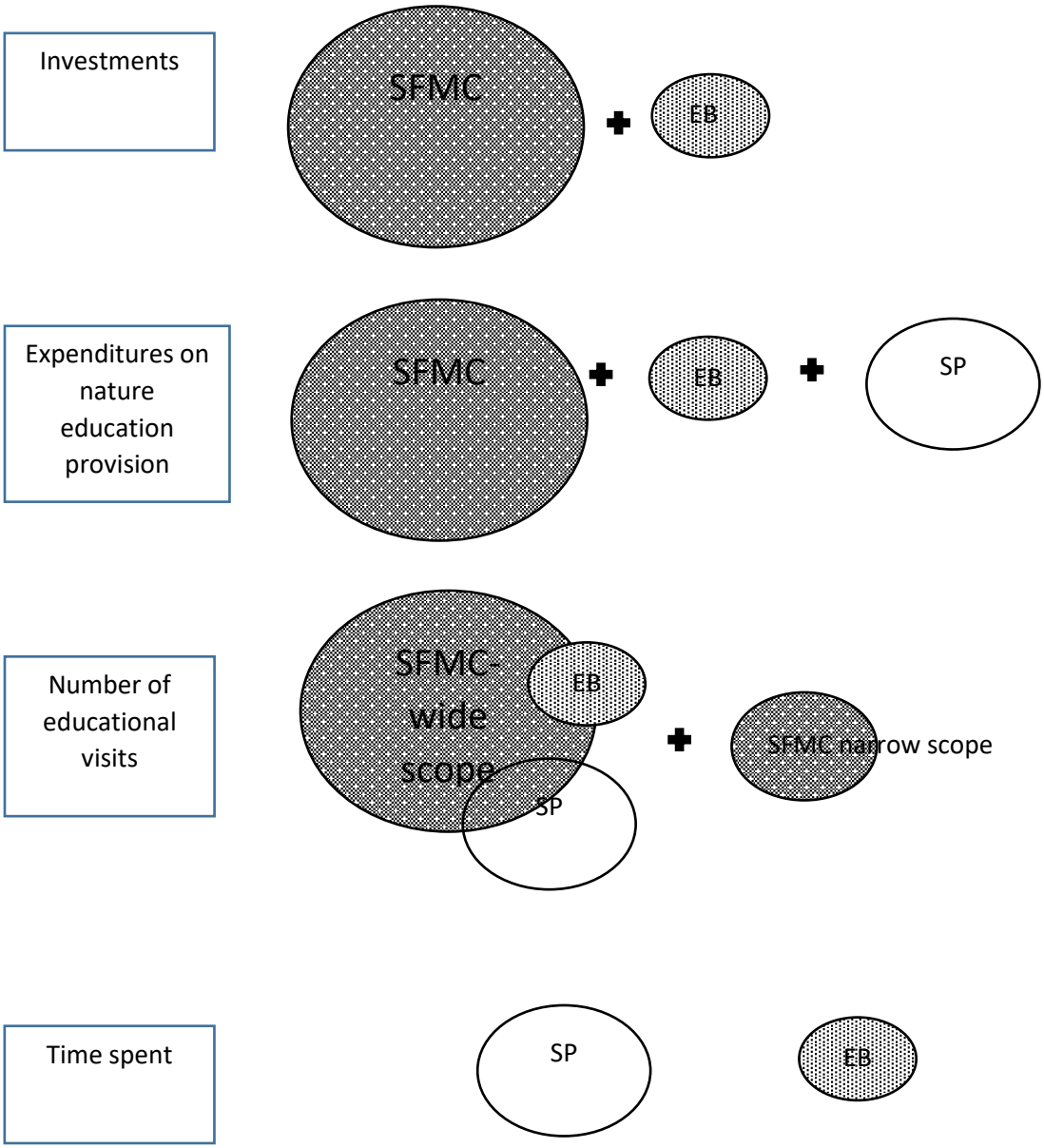
Way forward

In general, per unit ecosystem area, ecosystem service values depend both on socioeconomic variables and on education quality values that ecosystems can provide. The nature education ecosystem service values relevant to socioeconomic indicators have to be adjusted with the spatial context to specific educational capacity, potential and condition factors. In discussion paper 5.1: "Defining exchange and welfare values, articulating institutional arrangements and establishing the valuation context for ecosystem accounting" (prepared by the experts as part of the work on the SEEA EEA Revision coordinated by the United Nations Statistics Division) the proposed concept that exchange values (based on actual costs) of management constitute a lower bound for welfare values, could comprise also a solution how to address various qualities of nature education. The developed table (Table 5 "Categorization of nature education provisioning sites by nature education value") could be used as a basis for spatial distribution of nature education service values received by willingness to pay method. In future the applicability of the developed matrix for deriving of the potential capacity will be analyzed.

The aspects of the qualities (values) of nature education service and derived various estimates of nature education service value should be addressed in dialogue with wider ecosystem accounting community (ELME team: ecosystem services mapping and bio-physical supply currently, MAES application team, IPBES experts and others) and users in policy.

We agree with one of the key findings outlined in discussion paper 5.1: "Defining exchange and welfare values, articulating institutional arrangements and establishing the valuation context for ecosystem accounting"(prepared by the experts as part of the work on the SEEA EEA Revision coordinated by the United Nations Statistics Division) that given the importance of value transfer for accounting, specific guidelines on spatial scaling of monetary valuation estimates from primary study sites to accounting areas will be needed. We plan to take a step in that direction.

Annex 1. Schematic overview of the data sources for the expenditures and numbers of visits, overlap issues.



SMFC -State forest Management Center,

EB - Environmental Board,

SP – Service providers,

Annex 2. The supply and use of nature education service (thousand EUR), 2018

	Ecosystems	Corporations						General government			NPISH	Final consumption of households	Total
		Forestry (A.02)	Land transport (H.49)	Real estate activities (L.68)	Scientific and technical activities, (M.74_75)	Education (P.85)	Sports and recreation activities (R.93)	Public administration (O.84)	Education (P.85)	Creative, entertainment, culture (R.90_91)	Activities of membership organizations (S.94)		
Expenditure transfer approach													
Supply													**5 120**
Ecosystem service - nature education	5 120												5 120
Nature education													
Use													**5 120**
Ecosystem service - nature education													
Nature education												5 120	5 120
Value added (supply-use)	**5 120**												**5 120**
Expenditure based method													
Supply													**1 573**
Ecosystem service - nature education	273												273
Nature education		650		0	0	4	0	35	67	414	128		1 300
Use													**1 573**
Ecosystem service - nature education		208		0	0	0	0	3	7	41	13		273
Nature education												1 300	1 300
Value added (supply-use)	**273**	**442**		**0**	**0**	**4**	**0**	**31**	**61**	**373**	**115**		**1 300**
Travel cost based approach													
Supply													**2 023**
Ecosystem service - nature education	304												304
Nature education			1 719										1 719
Use													**2 023**
Ecosystem service - nature education			304										304
Nature education												1 719	1 719
Value added (supply-use)	**304**		**1 415**										**1 719**
Willingness to pay method													
Supply													**1 271**
Ecosystem service - nature education	1 271												1 271
Nature education													
Use													**1 271**
Ecosystem service - nature education												1 271	1 271
Nature education													
Value added (supply-use)	**1 271**												**1 271**

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