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International standards of economic analysis and their implementation in the case of Germany

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Cover picture: Section of a map of the Biosphere Reserve Elbe River Landscape, showing the origin of it visitors (Source: Authors).

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Abstract

UNESCO biosphere reserves are model regions for ecological, economic, and socio-cultural development, which align with the Rio sustainability paradigm globally. This holistic and integrative concept of area protection sees people as the central element of a national and worldwide network of unique and representative natural and cultural landscapes. Among this, nature tourism is a field of action of the biosphere reserves' development function, which triggers regional economic effects and thus contributes to the regional economic cycle.

This paper combines international key principles and definitions of the most relevant economic terms and approaches of economic analysis with the implementation of regional economic impact analyses in the case of German biosphere reserves. A research study detailed below commissioned by the Federal Agency for Nature Conservation, complied data on visitor days and structures, biosphere reserve affinity, visitor characteristics, visitor expenditure and economic effects across all 18 German biosphere reserves. The empirical data were collected and evaluated from 2010 to 2022.

The 18 German biosphere reserves count a total of 71.6 million visitor days. With an average day visitor share of 59.3 %, many of the German biosphere reserves are classic day trip destinations, except for the biosphere reserves on the coast. This in turn means that the areas are domestic tourism destinations, as only a few visitors come from abroad. At 80.3 %, most guests arrive by car. On average, 11.0 % are visitors with a high affinity for the biosphere reserve. For these visitors, the existence of the biosphere reserve plays a large or very large role in their decision to travel. On average, day visitors spend € 21.60 and overnight guests € 70.00 per person and day. The expenditure of visitors with a high affinity for the biosphere reserve deviates only slightly from the overall average. The 71.6 million visitor days in German biosphere reserves generate a gross sales of € 3.84 billion through their on-site expenditure. Nationwide biosphere reserve tourism thus generates a direct value added of € 1.32 billion and an indirect value added of € 646.87 million, i.e., a total of € 1.97 billion. As a result, 77,419 people can earn an income directly or indirectly from tourism in German biosphere reserves.

The analysis shows that only empirical data generated in situ can provide truly reliable information on the regional economic effects of tourism in German biosphere reserves, especially since the situation on-site changes constantly over time. The primary data obtained through empirical surveys can therefore be an impetus for a continuous integrative monitoring of this indicator. In a permanent update, the focus should be on regular surveys of the visitor structures on-site, which can be linked with official overnight guest figures to map the annual development of the visitation. The long-term goal should be the application of an automated and centrally coordinated regional economic model to continuously calculate the tourism value added in German biosphere reserves. This strategy should be communicated to the (expert) public as an integral part of the ten-year evaluation reports required by UNESCO. Appropriate measures on the part of the management can be derived from this and the experience gained from good practice can be fed into the world network of UNESCO biosphere reserves.

Zusammenfassung

UNESCO-Biosphärenreservate sind Modellregionen für eine ökologische, ökonomische und soziokulturelle Entwicklung, die im Einklang mit dem Rio-Nachhaltigkeitsparadigma auf globaler Ebene steht. Dieses ganzheitliche und integrative Konzept des Gebietsschutzes sieht den Menschen als zentrales Element eines nationalen und weltweiten Netzes von einzigartigen und repräsentativen Natur- und Kulturlandschaften. Darunter ist der Tourismus ein Handlungsfeld der Entwicklungsfunktion der Biosphärenreservate, der regionalwirtschaftliche Effekte auslöst und damit zum regionalen Wirtschaftskreislauf beiträgt.

Diese Publikation verbindet internationale Grundlagen und Definitionen der wichtigsten ökonomischen Begriffe und Ansätze der regionalökonomischen Wirkungsanalyse mit der Umsetzung dieser am Beispiel deutscher Biosphärenreservate. In einer vom Bundesamt für Naturschutz in Auftrag gegebene Forschungsstudie wurden die Ergebnisse zu Besuchstagen und -strukturen, Biosphärenreservatsaffinität, Besuchseigenschaften, Besuchsausgaben und ökonomischen Effekten für alle 18 deutschen Biosphärenreservate summiert. Die empirischen Daten wurden von 2010 bis 2022 erhoben und ausgewertet.

Die 18 deutschen Biosphärenreservate zählen insgesamt 71,6 Mio. Besuchstage. Mit einem durchschnittlichen Tagesgastanteil von 59,3 % sind die deutschen Biosphärenreservate vielfach klassische Tagesausflugsziele, mit Ausnahme der Biosphärenreservate an der Küste. Das wiederum bedingt, dass es sich bei den Gebieten um Binnentourismusdestinationen handelt, denn nur wenige Besucher*innen kommen aus dem Ausland. Mit 80,3 % reisen die meisten Gäste mit dem Pkw an. Im Mittel firmieren 11,0 % als Biosphärenreservatsbesucher*innen im engeren Sinne. Für diese Besucher*innen spielt die Existenz des Biosphärenreservats bei der Reiseentscheidung eine große oder sehr große Rolle. Im Durchschnitt geben Tagesgäste 21,60 € und Übernachtungsgäste 70,00 € pro Person und Tag aus. Die Ausgaben der Biosphärenreservatsbesucher*innen im engeren Sinne weichen im Mittel nur gering vom gesamten Durchschnitt ab. Die 71,6 Mio. Besuchstage in deutschen Biosphärenreservaten generieren durch ihre vor Ort getätigten Ausgaben einen Bruttoumsatz in Höhe von 3,84 Mrd. €. Der bundesweite Biosphärenreservatstourismus erwirtschaftet damit eine direkte Wertschöpfung in Höhe von 1,32 Mrd. € sowie eine indirekte Wertschöpfung von 646,87 Mio. €, d.h., insgesamt 1,97 Mrd. €. Dadurch können 77.419 Personen direkt oder indirekt ein Einkommen beziehen.

Die Analyse zeigt, dass nur durch in situ generierte empirische Daten wirklich belastbare Aussagen über die regionalökonomischen Effekte des Tourismus in deutschen Biosphärenreservaten gemacht werden können, zumal sich die strukturellen Situationen vor Ort im Zeitverlauf stetig verändern. Die durch aufwändige empirische Erhebungen ermittelten Primärdaten können deshalb ein Anstoß für ein fortlaufendes integratives Monitoring dieses Indikators sein. In einer kontinuierlichen Fortschreibung sollte der Fokus auf regelmäßige Erhebungen der Besuchsstrukturen vor Ort gerichtet sein, welche mit amtlichen Übernachtungsgastzahlen verknüpft die jährliche Entwicklung des Besuchsaufkommens abbilden können. Das langfristige Ziel sollte die Anwendung eines automatisierten und zentral koordinierten regionalökonomischen Modells sein, um die touristische Wertschöpfung in deutschen Biosphärenreservaten kontinuierlich zu berechnen. Als integraler Bestandteil der seitens der UNESCO geforderten zehnjährigen Evaluationsberichte gilt das der (Fach-)Öffentlichkeit zu kommunizieren. Daraus können entsprechende Maßnahmen seitens des Managements abgeleitet und hierbei gewonnene Erfahrungen guter Praxis ins Weltnetz der UNESCO-Biosphärenreservate eingespeist werden.

1 Introduction

In the “Sustainable Tourism Destinations in Germany” competition 2022/2023, a biosphere reserve once again won in the category “Advanced”. The Bliesgau Biosphere Reserve is thus considered a pioneer in terms of sustainability in Germany’s tourism destinations. The jury based its decision, among other things, on the fact that tourism in Bliesgau Biosphere Reserve drives sustainable development on all levels. Already in the last competition in 2016/2017, the Swabian Alb Biosphere Reserve won (Deutscher Tourismusverband e. V. 2023).

Faced with the fact of limited resources on earth, the idea for the interdisciplinary program “Man and the Biosphere” (MAB Programme) was born at the end of the 1960s (UNESCO 1968). In 1976, the first biosphere reserves were established on the ground. The contrast between protection and use of the natural environment was to be resolved in the form of worldwide model regions for the purpose of the most sustainable development possible. Under the responsibility of the United Nations Educational, Scientific and Cultural Organisation (UNESCO), these so-called biosphere reserves focus not only on nature conservation and environmental protection but also on the socio-cultural and economic aspects of sustainable regional development.

With the Seville Strategy of 1995, this claim was concretized by the definition of minimum criteria and the feature of sustainable development by humans was emphasized more strongly. Additionally, the land use was conceptualized by zoning the biosphere reserves into core area, buffer zone and transition area with different intensities of use (UNESCO 1996). Subsequently, the Madrid Action Plan (2008-2013) (UNESCO 2008), the MAB Strategy (2015-2025) (UNESCO 2017) and the Lima Action Plan (2016-2025) (UNESCO 2016) have constantly updated this objective and adapted it to fundamental global challenges such as climate change (Braun et al. 2020; Engelbauer 2022; Job et al. 2019). Moreover, the local level is emphasized more strongly today. Local and indigenous communities are to be involved in decision-making to strengthen effective partnerships and the network as a whole.

The UNESCO World Network of Biosphere Reserves currently comprises 748 sites in 134 countries (as of 06/2023, UNESCO 2023). Currently, 18 biosphere reserves in Germany will be pursuing the goal of large-scale protection of natural and cultural landscapes through lifestyles and economies that are as compatible with nature as possible (BfN 2023), 17 of which are recognized by UNESCO (currently, only Southern Harz Gypsum Karst Region is missing but hopefully will get the UN label in 2024). This task encompasses the entire spectrum of the economy, i.e., in addition to agriculture and forestry in the primary sector, also industrial and commercial production in the secondary sector, as well as the services in the tertiary sector, including outdoor recreation and nature-based tourism. The latter is often emphasized nationally and internationally in the form of tourism valorization of biosphere reserves (Job et al. 2017).

In many places, tourism based on the natural attractions of an area serves as a preferred field of action within the development function. It is ideally also able to build up regional economic cycles in the primary and secondary sectors through its economic multiplier effects (Merlin 2017). Thus, not only the tourism businesses within a biosphere reserve benefit from the visitors’ activities there, e.g., if they stay overnight during a (short) holiday or only stop at a restaurant during a day trip (= direct regional economic effects). Additionally, their tourism businesses purchase intermediate services to be able to offer their own product at all. For example, they work together with local bakeries, butchers, or laundries, which in turn use inputs

from agriculture (= indirect regional economic effects). In this way, a diverse regional economic network can be created, and a multiplier effect triggered, which originates in tourism (Knaus 2013; Kraus et al. 2014; Pütz/Job 2016).

In 2002, a pilot study in the Berchtesgaden National Park was the first to assess the regional economic effects of nature-based tourism in a German national park (Job et al. 2003). Subsequently, a standardized procedure was developed (Job et al. 2005), which has now been applied in all German national parks (Job et al. 2009; 2016) and, with the present report, in all German biosphere reserves, too. Within a first research project commissioned by the Federal Agency for Nature Conservation entitled "Economic effects of tourism in German biosphere reserves" between 2010 and 2012, the Biosphere Reserves Palatinate Forest, Rhön, Schaalsee, Spree Forest, Southeast-Rügen and Thuringian Forest were examined (additionally, regional value chains in the Rhön were analysed in more detail using the example of the Rhön umbrella brand there; Job/Kraus 2014; Kraus 2015). Based on the visitation data for these six biosphere reserves, it was possible to extrapolate the first overall number of biosphere reserve tourism in Germany (Job et al. 2013).

After completion of this first research project, a second one entitled "Determining the socio-economic effects of tourism in German UNESCO biosphere reserves" was initiated, again on behalf of the Federal Agency for Nature Conservation. Between 2016 and 2022, the Biosphere Reserves Bliesgau, Drömling, Elbe River Landscape, Southern Harz Gypsum Karst Region, Upper Lausitz Heath and Pond Landscape, Schorfheide-Chorin as well as Swabian Alb were examined. The project was connected with other scientific projects in Black Forest Biosphere Reserve (commissioned by Deutsche Bundesstiftung Umwelt; Job et al. 2020; Majewski 2024), Lower Saxony Wadden Sea National Park and Biosphere Reserve (commissioned by Lower Saxony Wadden Sea National Park Administration; Job et al. 2023a), Hamburg Wadden Sea National Park and Biosphere Reserve (commissioned by Free and Hanseatic City of Hamburg; Job et al. 2023b), Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserve (commissioned by Schleswig-Holstein National Park Foundation; Job et al. 2023c) and Berchtesgadener Land Biosphere Reserve (commissioned by Government of Upper Bavaria; Job et al. 2023d). This project series, which has been carried out since 2010, has resulted in a fully comprehensive database for all 18 biosphere reserves in Germany.

Data collection and analysis followed a standard procedure to ensure comparable data. A standardized approach for measuring the economic impacts of tourism in protected areas is published in a UNESCO guideline by Spenceley et al. (2021). This guideline aims to help national stakeholders, protected area managers, and researchers to count visitation consistently, and to reliably evaluate its economic impacts. On a national and international scale, a standardized approach will also help fulfil international reporting requirements to global conventions. Only a globally consistent methodology for data gathering will allow stakeholders to compile and compare regional and global data sets in between the 'World Network of Biosphere Reserves'.

This report merges the UNESCO guidelines on standard metrics, definitions, and methodological issues (Spenceley et al. 2021) with the procedure applied for German Biosphere Reserves. Considered as a national case study, the results for nature-based tourism visitor days and structures, affinity, visitor characteristics, visitor spending, and economic effects in Germany's biosphere reserves are presented. Based on this, the report offers policy implications for long-term monitoring for Germany and for UNESCO biosphere reserves in general as well.

2 General approach: the Big Picture

The following section provides an overview of the "big picture" for the economic analysis of visitation in UNESCO Biosphere Reserves, including key principles and definitions of the most relevant economic terms and approaches.

Glossary

Day visitor

Visitor who visits the biosphere reserve for a day trip, i.e., does not stay overnight. Day visitors need to be separated from locals who are not defined as visitors from outside the biosphere reserve.

Direct effects

Changes on the economy caused by visitor spending in tourism businesses that sell directly to visitors.

Economic effect

Changes on the economy caused by visitor spending, such as on income, jobs, value added, taxes, etc. Economic effects can be distinguished into direct, indirect, and induced economic effects.

Income equivalent

Number of persons who receive an income from visitor spending.

Indirect effects

Intermediate consumption effects generated by directly affected tourism businesses buying goods and services from other businesses within the local region. The cycle of spending ripples backward through the supply chain until all money leaks the local economy.

Induced effects

Consumption effects generated through household spending of personal income received directly or indirectly from visitor spending. Induced effects cannot be calculated by the value added analysis.

Intermediate consumption

The value of the goods and services consumed or processed in the productions process to provide tourism goods and services.

Multiplier

Coefficient describing the relationship between the total economic effects (direct, indirect, and induced effects) to direct effects. The multiplier is used to convert visitor spending into the value of associated value added or job effects and its circulation in the regional economy.

Overnight guest

Visitor who stays overnight in the biosphere reserve as part of a (short) holiday.

Value added

Value of output less the value of intermediate consumption. It includes domestic employee compensation, net operating surplus, other taxes on production less subsidies and depreciation.

Value added analysis

Method for determining the tourism value added and employment effects (= income equivalent) of biosphere reserves. Direct and indirect effects are estimated by value added quotes.

Value added quote

Economic ratio to determine the direct value added. Share of value added in the output of visitor spending. The remaining amount is intermediate consumption.

In value added analysis, economic ratio to determine the indirect value added. Share of value added in the intermediate consumption. The value added analysis used here assumes a general value added quote of 30% for all tourism sectors and for each biosphere reserve.

Visitor days

The total number of days that visitors stay in the biosphere reserve.

Visitor spending

The total consumption expenditure made by a visitor, or on behalf of a visitor, for goods and services during his/her trip and stay at a biosphere reserve and its surroundings.

Visitors with a high affinity for the biosphere reserve

Visitor to a biosphere reserve who is aware of the existence of the biosphere reserve in the region and for whom the biosphere reserve plays a major or very major role in their travel decision.

2.1 Economic effects: direct, indirect, induced, and total effects

The money visitors spend during their stays in biosphere reserves has a range of economic effects in the form of regional value added or jobs, not only for the tourism service providers but also for local suppliers and other businesses through a value added process in the entire regional economic cycle. We distinguish direct, indirect, or induced effects.

During their trip to the biosphere reserve, visitors spend money locally. They may stay overnight in a hotel or on a campsite, go to a restaurant, buy local products like food, drinks, or souvenirs like handicrafts, and pay for services such as guided tours, hiring equipment, local transport, or tickets to attend events or performances. The visitor spending generates a local value added and creates jobs, which defines the **direct effect** on the local economy and means the changes caused by visitor spending in businesses that sell directly to visitors. For instance,

a local business sells products and services to visitors and spends the money that it receives from visitors beforehand. A restaurant, for example, may buy vegetables from local farmers or bread from a bakery. The spending by these other businesses has an **indirect effect** on the local economy. It means the intermediate consumption generated changes when tourism businesses and other directly affected enterprises buy goods and services from others within the local area.

Furthermore, the people who receive income from providing products and services to visitors – including their salaries or tips – spend parts of that money locally. For example, they may use it to support their families and purchase household goods such as groceries and clothes or pay for childcare or security services. Thus, the visitor spending initiates **induced effects** on the local economy, generated through household spending of personal income received directly or indirectly from visitor spending. The value added analysis carried out for the German biosphere reserves cannot estimate the induced effects. In contrast, multiplier estimates based input-output models can assess these induced effects (Chapter 5.4).

The total economic effects of visitor spending are the sum of the direct, indirect, and induced effects (the latter two are also called secondary effects):

Total economic effects	=	Direct effects	+	Indirect effects	+	Induced effects

The regional economic effects of tourism in biosphere reserves thus result from the days spent on-site by day visitors and overnight guests (number of visitor days) and the expenditure they incur. The economic impulse released by this is expressed by the regional economic multiplier effect. The multiplier describes the multiplication of tourist expenditure and thus measures the ratio of the total volume of regional economic effects (direct, indirect, and induced effects) to the original expenditure (Archer 1977). The regional economic effects of tourism are calculated by multiplying the three parameters:

Total economic effects	=	Number of visitor days	x	Visitor spending	x	Multipliers

Data on the number of visitor days, visitor structures and the average daily expenditure was collected in all German biosphere reserves on the demand side through empirical on-site surveys according to a standardized procedure (Chapter 3.4). It was analysed using the same methodology (Chapter 3.5): The tourism value added analysis was applied as a standard for the regional economic effects calculation, which expresses regional economic multipliers through value added ratios (Chapter 5.2; Job et al. 2013; 2020; Woltering 2012).

2.2 Economic contribution vs. economic impact

There are two main economic terms that describe the economic activity of visitation to biosphere reserves: economic contributions and economic impacts. Both can be subdivided into direct, indirect, and induced economic effects of tourism spending, and they include effects on income, jobs, value added, output, and taxes, to name a few.

Economic contributions describe the gross economic activity associated with tourism spending within a regional economy. The results of an economic contribution analysis can be interpreted as the relative magnitude and importance of the economic activity generated through visitor spending in a regional economy. Economic contributions are estimated by multiplying total visitor spending (of all visitors, including locals) by regional economic multipliers. Contribution analyses are often used to demonstrate and communicate the importance of biosphere

reserve tourism to the economic vitality of the local region or national economy. They track the share of the total economic activity related to the biosphere reserve under review. Such analyses are common, requiring less data and expertise than economic impact studies.

Economic impacts describe the net effects of policies that bring new revenues into the biosphere reserve that would otherwise not occur or policies that keep revenues in a biosphere reserve that would otherwise be lost. Economic impact analyses are often used to estimate how visitation or visitor spending changes might affect local economies. Economic impacts describe the economic activities that are either brought into a region because of a (newly established) biosphere reserve or the economic activity that would be lost if the biosphere reserve designation was removed. While the economic contribution represents the economic effects that result from the spending of all biosphere reserve visitors, the economic impact only considers the economic effects that result from the spending of biosphere reserve visitors from outside the region **because** of the biosphere reserve. Therefore, the economic impact does not include spending by locals (Dwyer et al. 2010; Watson et al. 2007).

2.3 Estimating economic impacts of Germany's UNESCO biosphere reserves

In Germany, visitors who come to the region because of the biosphere reserve are operationalized by visitors with a high affinity for the biosphere reserve. This core group of visitors is separated from other biosphere reserve visitors by a threefold filter question sequence in the survey questionnaire. First, knowledge about the protected status of the region is asked, and the plausibility of the information is checked. Suppose the existence of the biosphere reserve is known. In that case, a significant role of the biosphere reserve for the travel decision separates the visitors with a high affinity for the biosphere reserve. All other visitors are referred to as other biosphere reserve visitors (Figure 1).

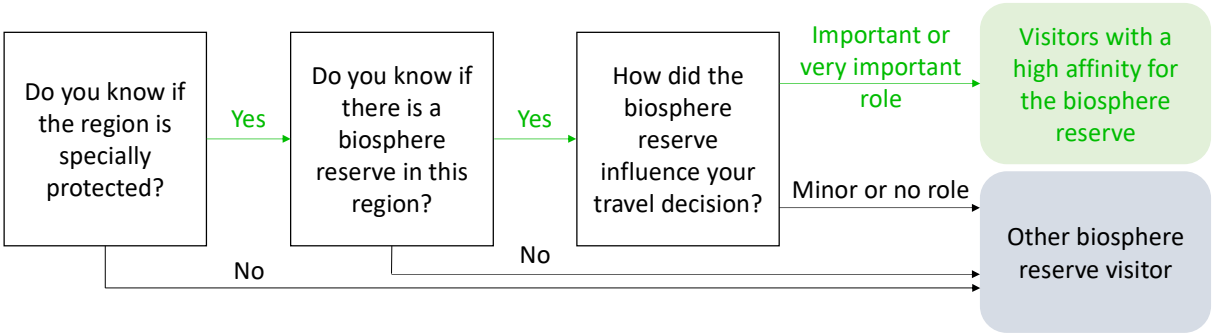


Figure 1: Operationalization of visitors with a high affinity for the biosphere reserve

3 Visitor counting

3.1 What to count?

The starting point of all economic analyses for biosphere reserves and other protected areas is a reliable and accurate estimate of the total annual visitation to the area. Research has shown that visitation differs greatly across biosphere reserves (Chapter 3.6). Visitor counting programs need to be designed with caution to obtain accurate visitation figures while efficiently using available resources.

Generally, in a visitor evaluation or monitoring program, **entrants, visits, visitors, or visitor days** can be counted (Figure 2).

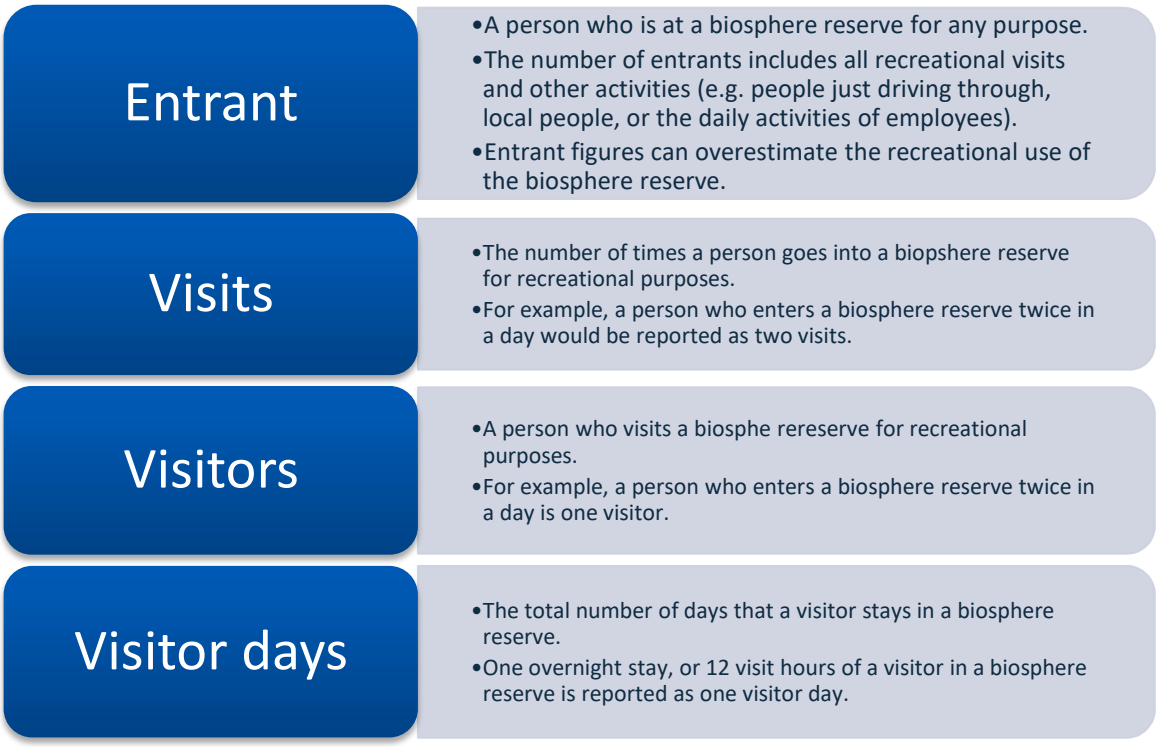


Figure 2: What to count – entrants, visits, visitors and visitor days

The difference between **visits, visitors and visitor days** can be explained as follows (Hornback/Eagles 1999; Kajala et al. 2007): Any person visiting a biosphere reserve for tourism or recreational purposes as a day-tripper or overnight guest is defined as a **visitor**. The same person can visit a biosphere reserve several times within a year or during his or her holidays in the region, i.e., make several **visits** to the biosphere reserve. Thus, while visitors are defined as those who make a certain number of visits to a park, **visitor days** are defined as the total number of days that visitors spend in a biosphere reserve. The number of visiting days for overnight visitors can be different from the number of days they stay in the (perhaps wider) biosphere reserve. Only the days on which the biosphere reserve was visited should be considered.

3.2 Counting methods: How to count?

There are many ways to count, which fall under three broad types: **direct, indirect, and automated** (see Figure 3). Every counting method has advantages and disadvantages (see Table 1), and the option selected will depend on the policy needs, available financial resources, labor costs, available staff and expertise, the characteristics of the site of interest and the desired sampling strategy.

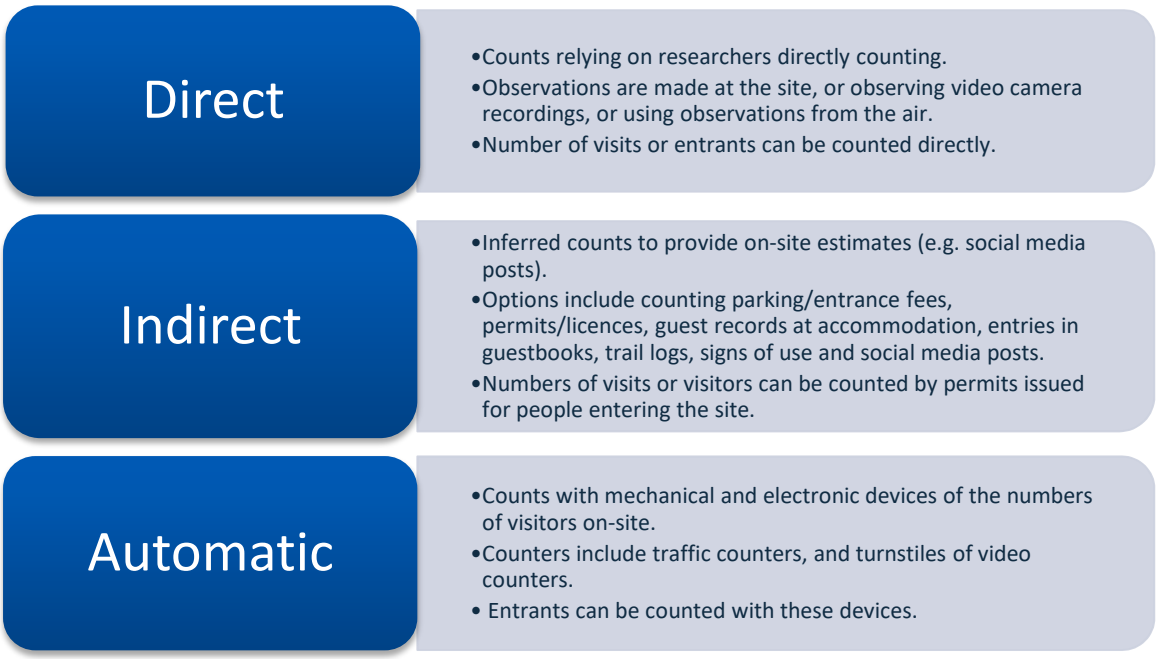


Figure 3: How to count: direct, indirect, and automated methods

To illustrate some considerations:

- **Direct counts:** Personal on-site counting has the advantage of providing flexibility to counting times and locations. While it requires minimal equipment and a certain level of expertise, it is labor-intensive and may only be used where counts are made over a limited period or where there is a lack of funds for automated counters. Nevertheless, by employing local people or using volunteers for visitor counting, a biosphere reserve may enhance local engagement with its stakeholders and communities.
- **Indirect counts:** Accurate indirect count information may be available from counting entrance tickets (or records of permits sold) if visitors require these to enter a site. These can provide an easy and accurate way to estimate the number of visits. Other data sources include the number of guests staying at accommodations in the biosphere reserve or the number of passengers transported to a tourist attraction (e.g., by buses or boats). However, the usefulness of such data sets for visitor counting depends on their accuracy, the share of the total visitors covered by the data, and the share of people covered by the data who are not visitors. For example, the number of entrances may be underestimated because (a) biosphere reserves generally do not have official entrance gates visitors can enter, (b) staff may not declare all permits issued, or (c) accommodations may not report all their guests. Other indirect methods include observations of trail use and volumes of waste accumulation. However, these require expert knowledge and may not result in accurate visitation figures covering the entire biosphere reserve. Self-registration counting

methods, such as accommodation guest books, also provide a low-cost visitor counting option. However, not all visitors complete them, and therefore, the level of accuracy is low. Adjustments may be required to control the sources of errors.

- **Automated counts:** Automated counting devices require high investment costs for purchasing, mounting, and calibrating them as well as training staff. They need to be calibrated to check that they count all visitor movements installed in appropriate locations and do not count other things (e.g., passing wildlife or leaves falling from trees). They may also not be able to distinguish between entrants and visitors. Unfortunately, devices may be vandalized. Their accuracy also depends strongly on the way they are set up and the type of device. Recent advances in automated counting devices allow them to distinguish between different user groups. They may have batteries lasting for up to 10 years and can transmit counting records through mobile phone networks. A big advantage of automated counters is that they may continuously count visitor movements all year round after installation. Due to their mounting and calibrating requirements, they are not as flexible for covering multiple counting locations as direct methods. While some devices may be moved relatively easily (e.g., optical counters), others require built-in structures (e.g., turnstiles, gates). However, investment in automated counting devices may pay off if labor costs are high, long counting periods are planned, visitor counting programs are considered to last for more than one year, or locations are remote or difficult to access.

Sometimes, it is appropriate to use a combination of these methods together. It is important to only count each visitor once on the same day. With direct counts and automated counters, ensure that visitors are not counted twice, for example, in both directions on a hiking trail.

Vast amounts of “big data” available in the digital age also expand our opportunities to estimate visitor numbers, and these still need to be explored. For example, smartphone apps such as geocaching or sports activity trackers record detailed movement patterns and the activity of recreational visitors. Smartphones also offer great opportunities to engage a wider public in citizen science by allowing them to voluntarily contribute data on their recreational activities and locations. Mobile phone traffic and Wi-Fi tracking could be used to monitor visitors and their movements on-site (as it is already used to estimate traffic jams). In addition, the vast amount of data from social media platforms could be analysed to estimate users’ recreational behaviour. Search engine queries reveal interest in certain locations, while crowdsourced photo posts on platforms like Flickr are used to estimate visitor numbers at various sites (e.g., Sinclair et al. 2020; Wood et al. 2020).

Table 1: Overview of the visitor counting options

Counting Method	Description	Advantages	Disadvantages
Direct observation methods			
Personal counting	Trained staff counts visitors passing the counting location	High accuracy; high flexibility (spatial & temporal); low investment costs; simple, no validation; can be used for calibration of counting devices; visual interpretation of visitor characteristics; combination with interviews	High labor costs for long term counting
Camera Recordings	(Time-lapse) video or photographic recordings on-site combined with a manual or computer aided visitor count on the videos or photographs	High accuracy; high temporal flexibility; real-time monitoring possible using digital cameras with image transmission via high-speed mobile data; visual interpretation of visitor characteristics	Low spatial flexibility; high labor costs (if no computer-aided counts are feasible); high investment costs; expert knowledge for installation; short battery life; privacy issues
Remote Sensing	Aerial photography (drones, planes or satellite)	Accuracy from low to high (depending on set-up); high spatial flexibility; large-area coverage with regular repetition; assessment of visitor distribution possible; investment costs are decreasing (e.g., for drones)	High investment costs; expert knowledge for operation; most devices only usable in open spaces and cloudless conditions; automated image recognition counting still under development; still limited experiences; privacy concerns
Indirect observation methods			
Permits, bookings, fees, licenses	Records of entry permits sales, facility or trip bookings and customer data from private travel, accommodation, or facility providers	Accuracy from low to high (depending on data sources and local circumstances); all year coverage; low costs; simple (if no corrections)	Validation & calibration (depending on data source); data only available for some sites / and/or locations within the site; subject to visitor compliance; subject to cooperation of private enterprises
Indicative counts	Counts of elements linked to visitor traffic/use (e.g., public transport, litter, trail use etc.)	Mainly low accuracy (depending on data source and local circumstances); all year coverage, low costs	Expert knowledge for operation; validation & calibration; data only available for some sites and/or locations within the site; no date/time reference
Visit registers	Count of voluntary or compulsory self-registration of visits (e.g., hut or other site guest books, track registers)	Medium accuracy, all year coverage; low costs; simple (if no corrections); long history of experiences in some regions	Accuracy differs by user groups; validation & calibration; data only available for some sites and/or locations within the site; subject to visitor compliance

Counting Method	Description	Advantages	Disadvantages
Automatic observation methods			
Mechanical counters	Counts with the help of mechanical devices (e.g., turnstiles, gates) triggered through a physical movement/displacement	Medium accuracy; continuous long-term counting; medium investment cost; low labor costs; simple; can be linked to electronic loggers; long history of experience	Low spatial flexibility; specific on-site structures; validation & calibration
Pressure	Counting by reaction of pressure counters to the steps of the visitors triggering a sensor (e.g., pressure pads, pneumatic tubes, sensor cables) which transmits the count data to a data recording device	Medium accuracy; continuous long-term counting; medium investment costs; low labor costs; wide variety of technologies for different situations (e.g., people, vehicles) that can be connected to various devices (e.g., camera, video, electronic loggers); relatively easy handling (easy to hide away, small size and weight, weather-proof)	Low spatial flexibility; expert knowledge for installation & operation; wildlife may trigger counts; possibly temperature-responsive; limited battery life; usually needs to be built into a structure
Active optical counters	Counting by interruption of light beams (e.g., active infrared, visible) with transmission of the count to a data recording device	Medium accuracy; continuous long-term counting; low to medium investment costs; low labor costs; long range across wider tracks; relatively easy handling (small size and weight, weather-proof); low power use	Medium spatial flexibility; validation & calibration; wildlife or branches may trigger counts; expert knowledge for installation & operation (alignment of transmitter and receiver); alignment highly sensitive to disturbance; hard to conceal and thus susceptible to vandalism; limited battery life
Passive optical counters	Counting by changing a background infra-red signature (e.g., passive infra-red) with transmission of the count to a data recording device	Medium accuracy; continuous long-term counting; low to medium investment costs; low labor costs; relatively easy handling (small size and weight, weather-proof); low power use	Medium spatial flexibility; validation & calibration; expert knowledge for installation & operation; false counts due to infra-red signature masking clothes, lighting changes or big groups; limited battery life
Magnetic sensing counters	Counting by changing magnetic fields caused by passing metallic objects (e.g., vehicles, sports and camping gear) with transmission of the count to a data recording device	Continuous long-term counting; medium investment costs; low labor costs; distinction between type of vehicle; relatively easy handling (small size and weight, weather-proof)	Low to medium accuracy (passengers per car unknown); low spatial flexibility; expert knowledge for installation & operation; validation & calibration; only useful for vehicle detection (including bikes); limited battery life
Microwave sensing	Counting by detection of changes in reflected radio waves from moving objects with transmission of the count to a data recording device	Continuous long-term counting; low labor costs; relatively easy handling (small size and weight, weather-proof); vehicles and people	Low to medium accuracy (tend to undercount groups); low spatial flexibility; high investment costs; expert knowledge for installation & operation; validation & calibration; require a clear line of sight; high power consumption; primarily used for cars

3.3 Visitor segments

It is generally advisable to segment visitor numbers because various visitor types exhibit distinct behaviors regarding their length of stay, activities, or spending habits. Splitting visitors into day and overnight segments is suggested as a minimum segmentation strategy. Segments can also be based on visitors' place of residence in relation to the biosphere reserve. For example, visitors could be classified into local visitors, non-local domestic visitors, and foreign visitors. Segments can also be classified based on visitor activities (e.g., camping, hiking, hunting, bird watching), locations within the sites (e.g., northern vs. southern entries) or socioeconomic characteristics (e.g., age groups, families). The survey questionnaire needs to include a question or a combination of questions that can be used to classify respondents into segments (Arnegger et al. 2010; Butzmann/Job 2017).

Visitor segment shares represent the percentage of biosphere reserve visits that fall into each segment and are used to split visit counts into visits by segment. Visitor structure surveys can be conducted prior to the main survey to gather information on visitor segment splits. If a pre-survey of visitor structure was completed, the analyst would already have information on the distribution of visits across visitor segments. If a pre-survey is not completed, the analyst can still estimate segment shares from the final expenditure survey. However, the percentage of survey respondents who fall into each visitor segment may differ from true segment shares if visitors in different segments have different likelihoods of being chosen to participate in the survey or if different segments have different response rates. These issues can be addressed by weighting responses based on other available data (Bowker et al. 2007).

3.4 Data collection in Germany's UNESCO biosphere reserves

When visitor counting in German protected areas began, it was subject to the official constraints on gathering tourism statistics, because information on day visitors, overnight guests staying at small businesses, or visitors staying with friends or relatives are not recorded officially. Furthermore, Germany's protected areas are, by law, freely accessible, the only limits being, for example, parking space capacity. Before 2000, figures on visitor numbers in protected areas were based mainly on estimates or expert judgements (Bibelriether et al. 1997); that is, approximate values that could not provide previously comparable, verified results for socioeconomic visitor monitoring by any standardized method.

Between 2000 and 2002, a pilot study was conducted to assess visitation and the economic impact of tourism in the Berchtesgaden National Park (Job et al. 2003). A standardized method for recording visitor numbers in other German protected areas was developed from 2003 to 2005, based on three case studies in the Müritz National Park and the Altmühltal and High Fläming Nature Parks (Job et al. 2005). Since 2006, this method to estimate visitation has been applied to all biosphere reserves (see Table 2), national parks, and some nature parks in several research projects (Job et al. 2009; 2013, 2016; Woltering 2012; Mayer 2013). The method is explained in detail by Job et al. (2021).

Survey instruments

For German biosphere reserves, visitor days, the total number of days a visitor stays in a biosphere reserve (Chapter 3.1), are calculated by standardized methods. The collection of primary data on visitation is the basis for the subsequent extrapolation of the total number of annual visitor days per biosphere reserve. As already described, there are various ways to

estimate visitation in a biosphere reserve (see Table 1). The research approaches applied in German biosphere reserves are based primarily on direct observation, namely on-site censuses, and official statistics on overnight stays. It should be noted that in some cases, automated counting devices were used in addition to this procedure. These devices function as reliable backups that can be used year-round, calibrate direct on-site observation counting, and validate extrapolation ratios (see Infobox 2).

The following survey instruments are used to estimate the total number of annual visits to a biosphere reserve and to assess the visitor characteristics, affinity, and spending patterns:

- **Counts** to determine the extent of visitor use. Those provide the basis for the calculations that will extrapolate the visitor structure data collected and data weightings.
- **Short interviews** (in combination with counts) to collect visitor structure data on length of stay, type of lodging, and postal code of residence.
- In addition to these two instruments, **long interviews** focus on travel characteristics, biosphere reserve affinity, and spending patterns, among other topics (Annex A and B).

Survey sites

On-site visitor surveys are applied at previously determined census points. Before data collection begins, the biosphere reserves' spatial structure and size variations must be considered. Compared to national parks in Germany, the biosphere reserves are often more extensive and always include human settlements in their transition zone. As mentioned earlier, the movements inside the biosphere reserves are diffuse (aside from restricted walkways through their core zones) because people live and work there. At the same time, visitors travel through the area on roads and specific tourist infrastructures. So, visitor flows are not channelled and cannot be clearly defined. Hence, the size of the study area and its spatial structure are determining factors for choosing census points. Census points are distributed across a biosphere reserve to collect comprehensive information on visitor use in conjunction with segmentation according to the following criteria:

1. size and perimeter
2. topographical conditions and infrastructure development (especially tourist infrastructure)
3. visitor structure and visitor behavior (outdoor recreational activities)
4. the zoning of the biosphere reserve
5. local or seasonal variations and specific events

First, the number of survey sites depends on the area's size and perimeter. Therefore, one survey site on the small terrestrial area of Neuwerk Island in the Hamburg Wadden Sea Biosphere Reserve and 14 survey sites in the large-scale Elbe River Landscape Biosphere Reserve (282,250 ha) were determined (see Table 2). **On average, 7.6 survey sites were used in Germany's biosphere reserves**.

Second, tourist infrastructure influences the flow of visitors once they enter the biosphere reserve. Therefore, counting and survey sites should cover the tourist diversity of the biosphere reserves. A relatively small number of census points will suffice if visitors concentrate on a few selected attractions or along certain routes. However, additional sites will be required if visitor use is more dispersed throughout the biosphere reserve.

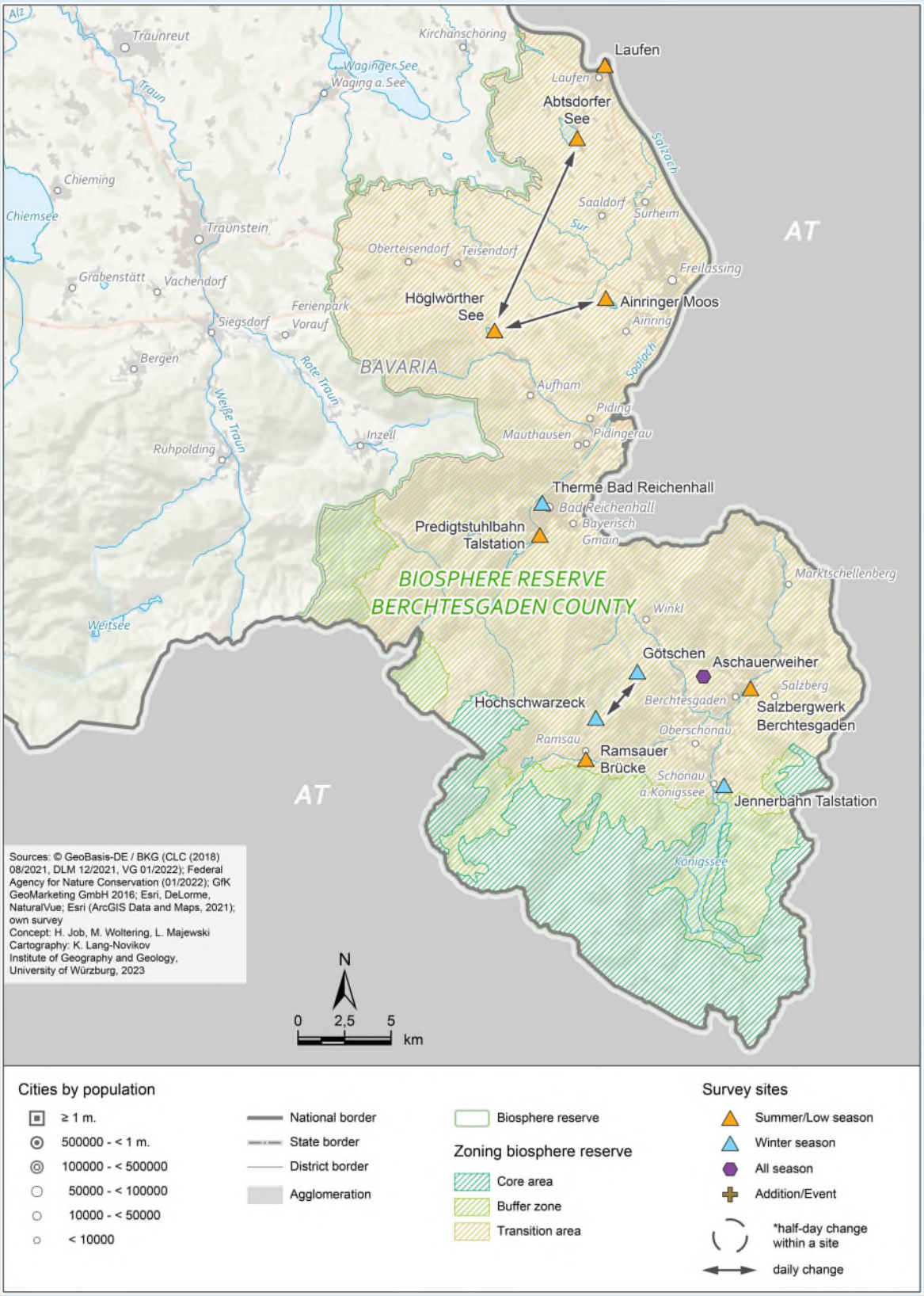
Third, when selecting locations for surveys and counts, the main tourism activities are considered in addition to the visitor structure (i.e., day visitors vs. overnight guests). All forms of tourism in the study area are included. German biosphere reserves represent near-natural and cultural landscapes where culture or spa-based tourism exists alongside nature-based tourism (Majewski/Job 2019; Majewski et al. 2019). It is, therefore, useful to collect data on the operational implementation at natural stopping points (e.g., parking lots). Because locals live in settlements within the boundaries of the biosphere reserve, it is necessary to separate locals from day visitors. They don't play a role as economic impact from outside.

Fourth, the factors mentioned above are supplemented by selecting census points at biosphere reserve locations used less by visitors, like in core zones, but where alternative activities (e.g., birdwatching) are practiced.

Fifth, seasonal variations in visitor use and activities must also be covered. For example, biosphere reserves in southern German mountain ranges receive high visitation rates in winter because of winter sports activities like skiing and snow hiking. Special events (including natural phenomena like bird migration) are also recorded as tourist attractions (Müller 2015; Herget et al. 2016).

For the on-site counting, a counting line was imagined to count the visitors who cross it. The basis for the subsequent projection of a total annual number of visitor days is the structure of visitor use. Even if it is impossible to adhere to a strict counting line (e.g., in a city center with no recognizable walking routes), a rough sample pattern is adhered to avoid overestimation due to double counting. In large biosphere reserves, research responds to a broader spread of visitor use by varying the survey sites. For example, with a seasonal or daily change, a broader sample could be collected (Infobox 1).

Infobox 1: Survey sites in Berchtesgadener Land Biosphere Reserve



In Berchtesgadener Land Biosphere Reserve, surveys were conducted on varying survey sites. The map shows different color symbols for seasonal changes as well as connecting arrows between the sites that change on a daily basis.

Survey period and survey day

According to analyses of official statistics on monthly overnight stays and arrivals, the shoulder season is characterized by increasing numbers of tourists in spring and decreasing numbers in autumn. Survey data is collected during a whole survey year, which is divided into the following fixed dates:

- winter season: November 15th-March 14th
- shoulder season I (spring season): March 15th-June 14th
- high/summer season: June 15th-September 14th
- shoulder season II (autumn season): September 15th-November 14th

On average, 17.2 survey dates were realized in German biosphere reserves. The number of survey dates ranged from 10 days on the Halligen and Pellworm (Schleswig-Holstein Wadden Sea) to 20 days in Rhön, Black Forest and Thuringian Forest. Again, size and spatial structure determine the ideal number of survey days in each area. If visitor registration focuses on censuses at central access points to smaller areas where seasonal variations (e.g., winter tourism) are to be expected, for example, 20 survey days can provide more detailed results. Data collection should also maintain a balanced ratio between weekdays and weekends, as differences in visitor use can be observed on daily and weekly curves. In some German biosphere reserves, winter sports activities play an important role. Especially in these areas, sufficient survey data must cover the winter season. Also, the shoulder season is characterized by a higher frequency of day visitors, which is particularly important in biosphere reserves located near urban areas.

Each survey day follows a chronological pattern. During the summer season, each study site is occupied from 9 am to 5 pm. In the winter season, with a shorter daylight span, the time is reduced from 10 am to 4 pm. All survey instruments (counts and short and long interviews) are combined during this period. A survey hour is divided into two periods: 40 minutes for long interviews, then 20 minutes for counts and short surveys. At the end of a day, a total of eight periods (or six periods in the winter season) of visitor counting and short questioning can be used to extrapolate the number of annual visits to a biosphere reserve.

All visitors who cross the defined counting line are counted. Different outdoor recreation activities are recorded separately: walkers, hikers, mountain bikers, canoeists, skiers, Nordic skiers, snowshoe/winter hikers, and so forth. Also, a frequency is determined that indicates the sampling rate of each respondent who is asked three questions:

- How many nights do you stay in the region? (0 nights = day visitor or local; >0 nights = overnight guest)
- In what type of accommodation do you stay? (for hotels: rate per person and night in €)
- What is the postal code of your main residence? (to find out who is a local and where guests are originating)

Combining counting and short interviews ensures that a random sample will be obtained. The random selection of respondents based on a certain sampling frequency means that the procedure is quasi-representative and allows bias to be excluded.

A total of **148,720 short interviews and 19,291 long interviews** were collected in German biosphere reserves (Table 2).

Table 2: Overview of the empirical surveys in chronological order

Biosphere reserve	Survey year	Survey period	Survey days	Survey sites*	Short interviews	Long interviews**
Thuringian Forest	2010/11	07/2010 – 06/2011	20	7	4,157	1,398
Rhön	2010/11	08/2010 – 07/2011	20	10	9,868	1,740
Palatinate Forest	2011/12	04/2011 – 03/2012	18	12	15,675	1,808
Spree Forest	2011/12	04/2011 – 03/2012	18	7	6,776	1,087
South-East Rügen	2011/12	05/2011 – 04/2012	18	6	8,940	833
Schaalsee	2011/12	06/2011 – 05/2012	18	7	7,155	959
Bliesgau	2016/17	06/2016 – 05/2017	18	6	5,245	801
Upper Lausitz Heath	2016/17	06/2016 – 05/2017	18	6	1,541	669
Swabian Alb	2016/17	06/2016 – 05/2017	19	10	6,842	1,401
Southern Harz	2017	01/2017 – 12/2017	18	5	5,994	740
Schorfheide-Chorin	2017/18	05/2017 – 05/2018	18	8	11,494	1,183
Elbe River Landscape	2018	01/2018 – 12/2018	18	14	18,564	1,844
Black Forest	2018/19	09/2018 – 08/2019	20	9	18,318	2,656
Lower Saxony	2019/20	08/2019 – 02/2020	16	12	13,314	1,484
Hamburg Wadden Sea	2019/20/21	08/2019 – 07/2021	16	1	1,020	308
Drömling	2020/21	09/2020 – 08/2021	14	7	2,514	639
Schleswig-Holstein Wadden Sea and Halligen***	2021/22	06/2021 – 05/2022	10	3	1,490	465
Berchtesgadener	2021/22	07/2021 – 06/2022	13	6	9,813	1.084
Sum/average			**17.2**	**7.6**	**148,720**	**19,291**

* full sites, i.e., without changing sites and without winter or additional sites
** without locals, without weighting
*** surveys and analyses of the biosphere reserve only concern the Halligen and Pellworm island.

3.5 Data extrapolation for estimating annual visitor days and structures in Germany's UNESCO biosphere reserves

The counts and short interviews at the individual survey sites form the basis for determining the annual number of visitor days and the underlying visitor structures. Three steps are necessary to achieve these results:

1. A specific daily use value is calculated for each of the survey locations on the individual survey days.
2. Based on these results for the individual survey days, average values for day types are then calculated to extrapolate the data to a whole survey year.
3. By using statistical overnight stays data, the day type values serve as the basis for extrapolation from the location-specific results to the whole biosphere reserve.

Step 1: Extrapolation of survey day data

As a first step of data analysis, the visitor groups are defined. Visitors staying one or more nights in a biosphere reserve are defined as overnight guests. Visitors with zero nights are either locals or day visitors. **GIS analysis seperates locals from day visitors because the economic impact analysis only considers new revenues from outside the region** (Chapter 2.2). For this purpose, a 2.5 km radius is set around each survey site. Using the postcode of the main residence, which was asked during the short interviews, an overlap of the visitors' radius of movement with their hometown is calculated. If the overlap of the radius with the postcode area was more than 25 %, the respondent is defined as a local.

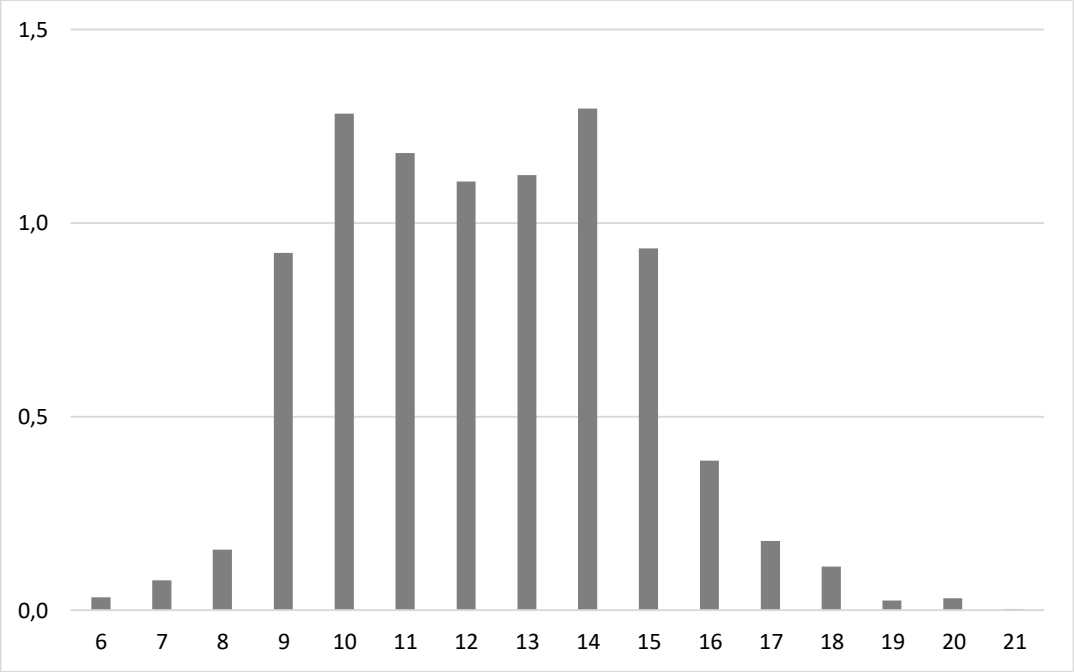
To estimate the **frequency at survey sites for the individual survey days**, the results from counting and short interviews are first to be extrapolated from the short survey period of 20 minutes to a full hour, using the specific frequency information for each recorded activity. For this purpose, the short interviews are multiplied by the calculated frequency, which is given by the division of the counted visitors and the number of conducted short interviews. Subsequently, minute values for each relevant visitor group (i.e., locals, day visitors and overnight guests) are determined and then extrapolated to the full hour.

In the next step, the hourly values for the individual activities are summed up while still differentiating between the three visitor groups. Then, the sum of all eight (or six in the winter season) survey hours is formed from these hourly values of all activities. If a survey hour is not available, the average value of the remaining survey hours of a day is used.

However, the values derived from this for locals, day visitors and overnight guests represent only a part of the day due to the previously defined survey times of eight or six hours, depending on the season. For this reason, the previous interim result for a survey location must first be extrapolated to a **core period of twelve hours** (7 am to 7 pm). This procedure assumes that the frequency in the early morning and towards evening is lower than during the day – regardless of the course during the day. A surcharge of ten percent on the previously extrapolated counting result for eight survey hours (or six in the winter season) is assumed for the missing four hours (or six hours in the winter season).

A distinction is made between the three tourism seasons to extrapolate the visitation data from the core period of twelve hours to a **24-hour full survey day** (Chapter 3.4). Based on empirical findings from automatic counting devices (Infobox 2 for an example), it is assumed that 2.5% of visitors pass through the counting point between 7 p.m. and 7 a.m. in the winter season, 5.0% in the shoulder seasons in spring and autumn, and 7.5% in the high season, which is characterized by longer summer days.

Infobox 2: Average visitor counts from 6 am to 9 pm at a census point in a core area of Swabian Alb Biosphere Reserve



Average value of accumulated movements (IN+OUT)

Step 2: Extrapolation to a survey year

Since **outdoor recreation activities dependent on weather conditions**, they influence the visitor numbers and the visitor structures in biosphere reserves. For the data extrapolation to a full survey year, "weather conditions" are included as a third variable besides "seasonality" and "day of the week". Area-specific data from local weather stations of the German Meteorological Service (DWD) are used for this purpose. This data is free of charge in a digital format for use in further calculations. The following weather variables are included:

- the average temperature for 24 hours
- daily sunshine duration in minutes
- daily rainfall in millimeters
- snow height in centimeters

First, a distinction between "good" and "bad" weather needs to be determined. For the summer and shoulder seasons, the three parameters "temperature", "sunshine duration" and "precipitation" are used because they influence the visitor activity during this time. As these variables are measured at different scale units, the values are standardized using the z-

transformation. The variables can be linked additively, and all parameters are thus equally weighted in the calculation: the sum of the z-standardized variables calculates the weather parameter. Rainfall is considered to have a negative impact on visitation, and hence evaluated with a negative value. For calculated values >0, “good” weather conditions are assumed, and values <0 represent “bad” weather conditions. This result is expressed with a dummy variable.

The parameters used in summer cannot be transferred to the winter season without adaptation due to the climatic conditions of the preferred outdoor activities. For example, in low mountain ranges or the alpine region, the parameter “snow height” rather than “rainfall” is a more suitable alternative. Furthermore, the variable “temperature” is included negatively in the calculation because high temperatures tend to negatively affect winter sports conditions as, for example, snow is melting.

After determining whether the daily weather is “good” or “bad”, **four day types can be classified, which result from the combination of “season: summer/shoulder/winter season”, “weekend: yes/no” and “weather: good/bad”**. From the results calculated in the previous section for the individual survey days, twelve day types are derived by calculating average values. These ideally represent a typical weekday or weekend day per season, again differentiating between good and bad weather.

With this data basis, the average number of visitor days and the visitor structures per day type can be calculated for the survey locations. Finally, this information can be used to derive visitor data for the entire season: The first step is to determine the number of days for the individual day types in the year. By multiplying the average values for the individual day types with the corresponding number of days in the year, the total number of visitor days and the ratio between locals, day visitors and overnight guests can be calculated. This number of visitor days represents the visitation on the survey sites. Therefore, this structure needs to be extrapolated to the entire biosphere reserve.

Step 3: Extrapolation with statistical data

The total number of visitor days to a biosphere reserve is calculated based on the visitor structure data in conjunction with data from the official tourism statistics. The official tourism statistics in Germany only include accommodation businesses with more than ten beds. For the recording of tourism in German biosphere reserves, this means that many small businesses (e.g., holiday homes/apartments, private accommodations) are not included, although they are particularly well represented in rural areas. Visits of friends and relatives are also not recorded, as there is no data on the mostly significant number of day visitors as mentioned above.

The basis of this last step of extrapolation is the number of officially recorded overnight stays for the biosphere reserve region (Infobox 3). The data on visitor structures from the short interviews are then used to calculate pro-rata surcharges for overnight stays in holiday homes and with friends and relatives to consider non-commercial and private overnight stays adequately.

After determining this overnight tourism segment for commercial, non-commercial businesses, and private stays, the day visitor share from the structural data is added to the overnight guest numbers. **Finally, the total number of visitor days for a biosphere reserve is calculated from the sum of the respective day visitors and overnight guests.**

Infobox 3: Defining the biosphere reserve region

The biosphere reserve region is defined as all municipalities located entirely or partly within the designated biosphere reserve. The official overnight stays for the biosphere reserve region are estimated using the number of overnight stays calculated in proportion to the area share of the municipality in the biosphere reserve. For example, if the area share of a municipality is less than 50% of the biosphere reserve, the number of overnight stays is included in the calculation only with the respective share value. This specification ensures that the number of visitor days is not unrealistically high; this would be the case in a large city with a relatively high number of overnight stays but only a small proportion of the municipal area within the biosphere reserve. For example, 20% of the urban area of the city of Magdeburg (the capital of Saxony-Anhalt) is located in the Elbe River Landscape Biosphere Reserve: If the total number of overnight stays for Magdeburg were to be included in the extrapolation of the biosphere reserve's visitor number, this would overestimate the biosphere reserve tourism by far. In such a case, the number of overnight stays is adjusted downwards in line with the area share value. For Magdeburg, 20% of the officially recorded overnight stays for a survey year are included in the calculations.

3.6 Results for Germany's UNESCO biosphere reserves: Visitor days and structures

The German biosphere reserves count 71.6 million visitor days (Table 3). The Lower Saxony Wadden Sea is a traditional holiday region with 21.7 million visitor days, far ahead of all other biosphere reserves, followed by Berchtesgadener Land with 7.4 million, the Swabian Alb with 7.1 million, Rhön with 6.4 million, Palatinate Forest with 5.7 million, and South-East Rügen with 5.3 million. The lowest numbers of visitor days were recorded in less important biosphere reserves for tourism like Drömling, Schaalsee, Southern Harz Gypsum Karst Region, Upper Lausitz Heath and Pond Landscape and Thuringian Forest, each with less than one million visitor days (see Figure 4). Regarding visitor movements within the region, the Hamburg and Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserves both hold a unique condition, as the designated areas within the biosphere reserve encompass relatively small sections of land. In the case of Hamburg, the touristic relevant area is only Neuwerk Island. In the case of Schleswig-Holstein, the biosphere reserve region is exclusively defined as the Halligen and the island of Pellworm.[1].

[1] The whole Schleswig-Holstein Wadden Sea National Park counts 21.4 million visitor days.

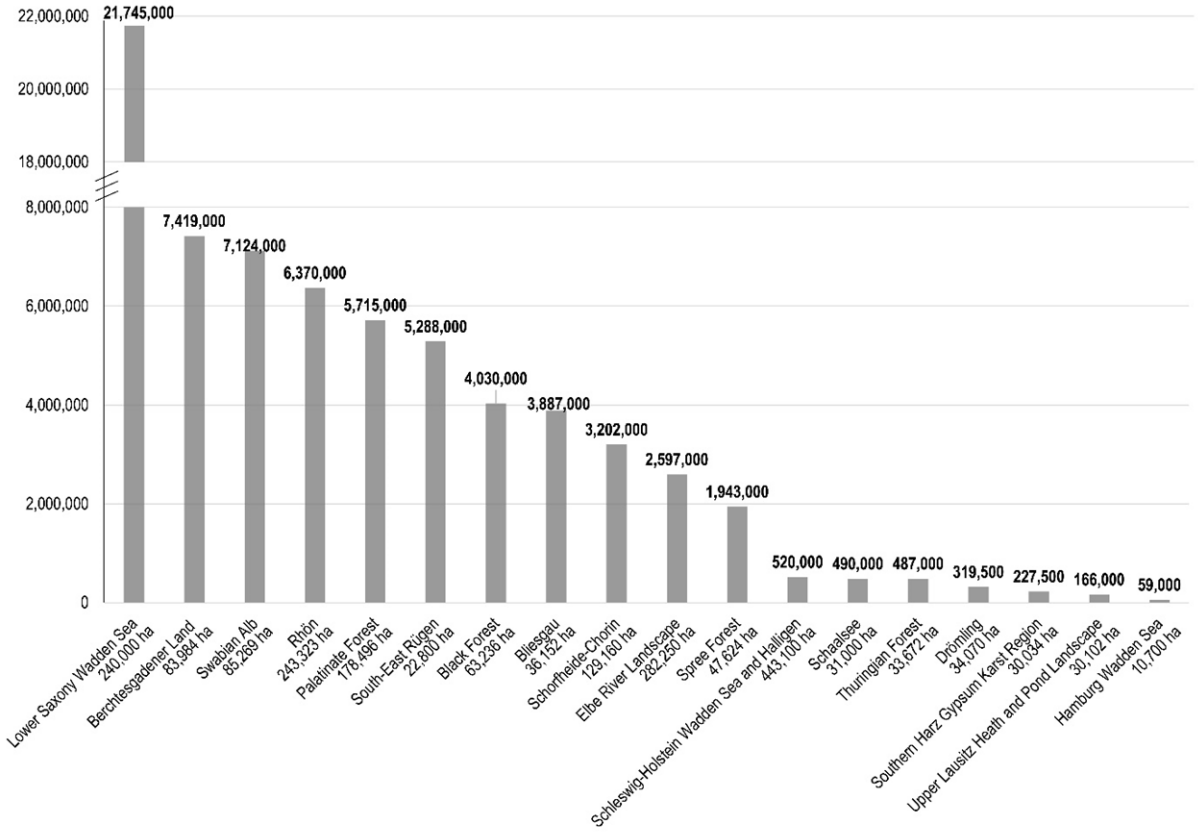


Figure 4: Number of visitor days in German biosphere reserves

In relation to the area size, the Lower Saxon Wadden Sea reaches the highest visitor density of 1,138 visitor days/ha. South-East Rügen, the smallest biosphere reserve at the time of the surveys, shows the second highest visitor density of 476.9 visitor days/ha (in relation to the area at that time) due to the high visitor frequency in the small area. Hamburg Wadden Sea follows with 201.2 visitor days/ha and Bliesgau has 107.5 visitor days/ha. The lowest visitor density is identified in the largest terrestrial biosphere reserve, Elbe River Landscape, with 9.2 visitor days/ha, Drömling with 7.0 visitor days/ha and Upper Lausitz Heath and Pond Landscape with 5.5 visitor days/ha.

The average day visitor share is 59.3%, and the overnight guest share is 40.7 %. This visitor structure shows the importance of the biosphere reserves as destinations for day trips within Germany. The highest proportion of day visitors is recorded in Drömling with 86.7%, followed by Bliesgau with 83.5%, Schaalsee with 82.4%, and Swabian Alb with 80.5% (see Figure 5). These structures reflect the location of the biosphere reserves within the larger urban areas of Wolfsburg, Saarbrücken, Hamburg and Stuttgart. In general, however, the catchment area varies. South-East Rügen Biosphere Reserve, important for overnight tourism, shows a dispersed distribution of visitors' origin, unlike the biosphere reserves close to agglomerations (Infobox 4). The biosphere reserves of Berchtesgadener Land, Rhön, Black Forest, Swabian Alb and Thuringian Forest also show a high proportion of day visitors because of winter sports activities.

The biosphere reserves Schleswig-Holstein Wadden Sea and Halligen with 49.8%, Black Forest with 42.9% and Spreewald with 48.7 % fall in the category of balanced day and overnight guest ratios. In these biosphere reserves, the day visitor share is just under half of all visitors. Just

above half are the biosphere reserves: Southern Harz Gypsum Karst Region with 57.4% day visitors, Berchtesgadener Land with 50.7% and Elbe River Landscape with 58.8%.

Only two of the 18 German biosphere reserves, Lower Saxony Wadden Sea with 9.3% and South-East Rügen with 6.7%, have a day visitor share of less than ten percent (see Figure 5). In these biosphere reserves on the coast, overnight tourism dominates, which illustrates their role as traditional holiday destinations within Germany and their peripheral spatial location. A unique situation arises in the two coastal biosphere reserves Hamburg and Schleswig-Holstein Wadden Sea, as mentioned earlier: In these instances, the proportion of day visitors is notably higher compared to the neighbouring biosphere reserve Lower Saxony Wadden Sea, with day visitors constituting more than half of all visitors in each case. This situation can be explained by the fact that visitors to Neuwerk Island and to the Halligen and Pellworm typically take a day trip from the mainland or other North Sea islands as part of an extended holiday at the North Sea. Consequently, they are classified as day visitors to Neuwerk Island or the Halligen and Pellworm because they do not spend a night there, unlike the original overnight visitors. The general observation that the coastal biosphere reserves have significant importance for overnight tourism holds for these two special cases as well when considering the movements of visitors on-site.

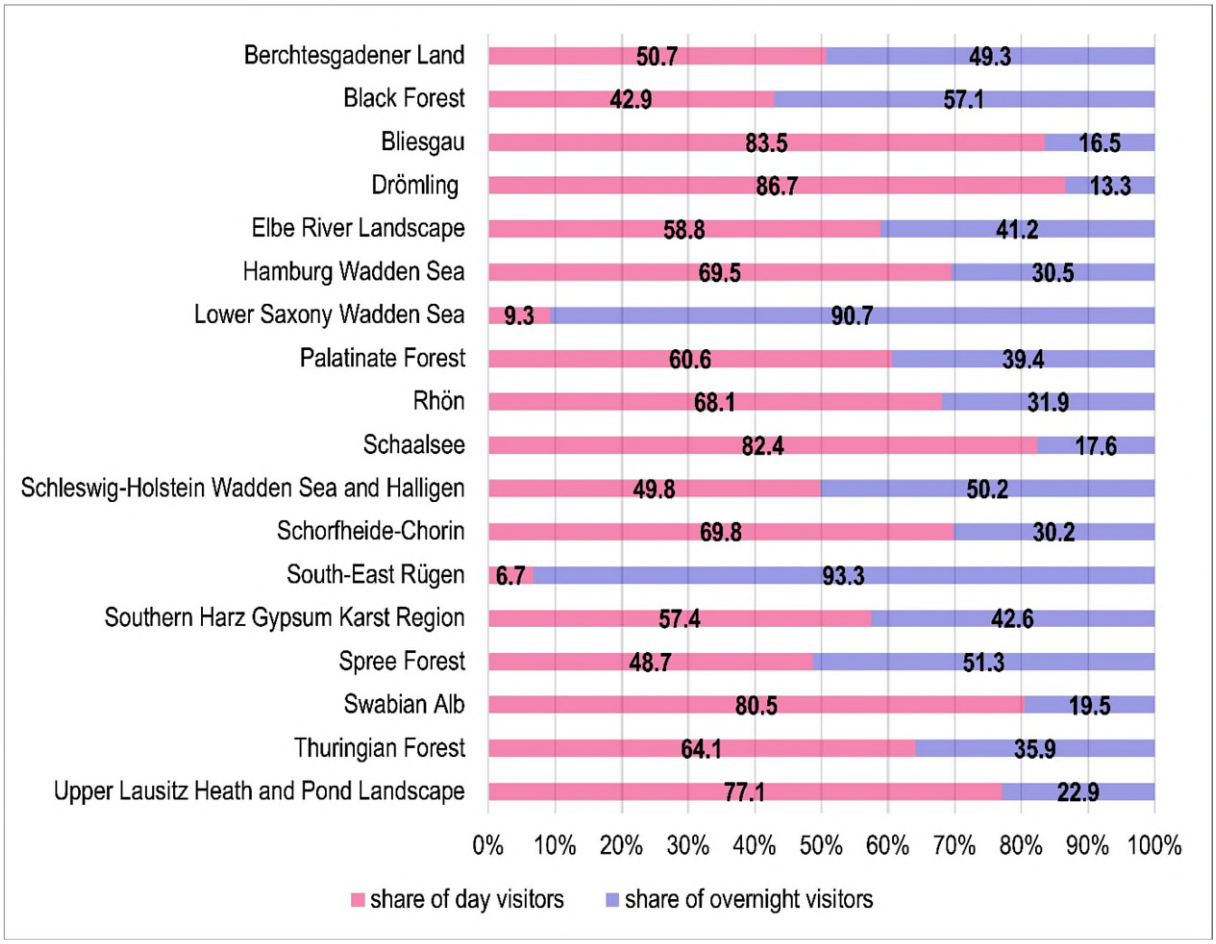
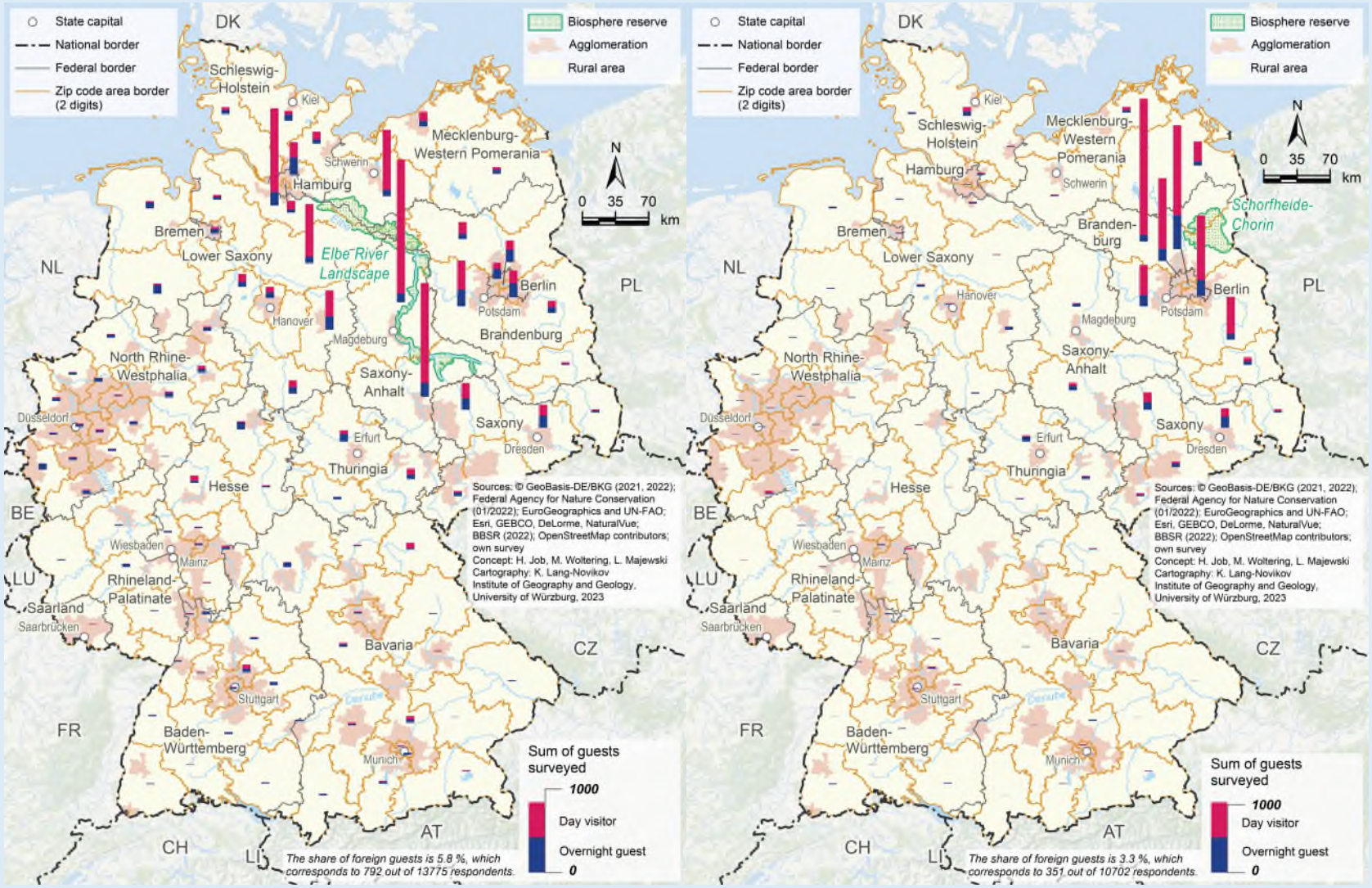


Figure 5: Share of day visitors and overnight guests in German biosphere reserves

Infobox 4: Comparison of the visitor's origin in Elbe River Landscapes, Schorfheide-Chorin, Swabian Alb and South-East Rügen Biosphere Reserves



Infobox 4: Comparison of the visitor's origin in Elbe River Landscapes, Schorfheide-Chorin, Swabian Alb and South-East Rügen Biosphere Reserves

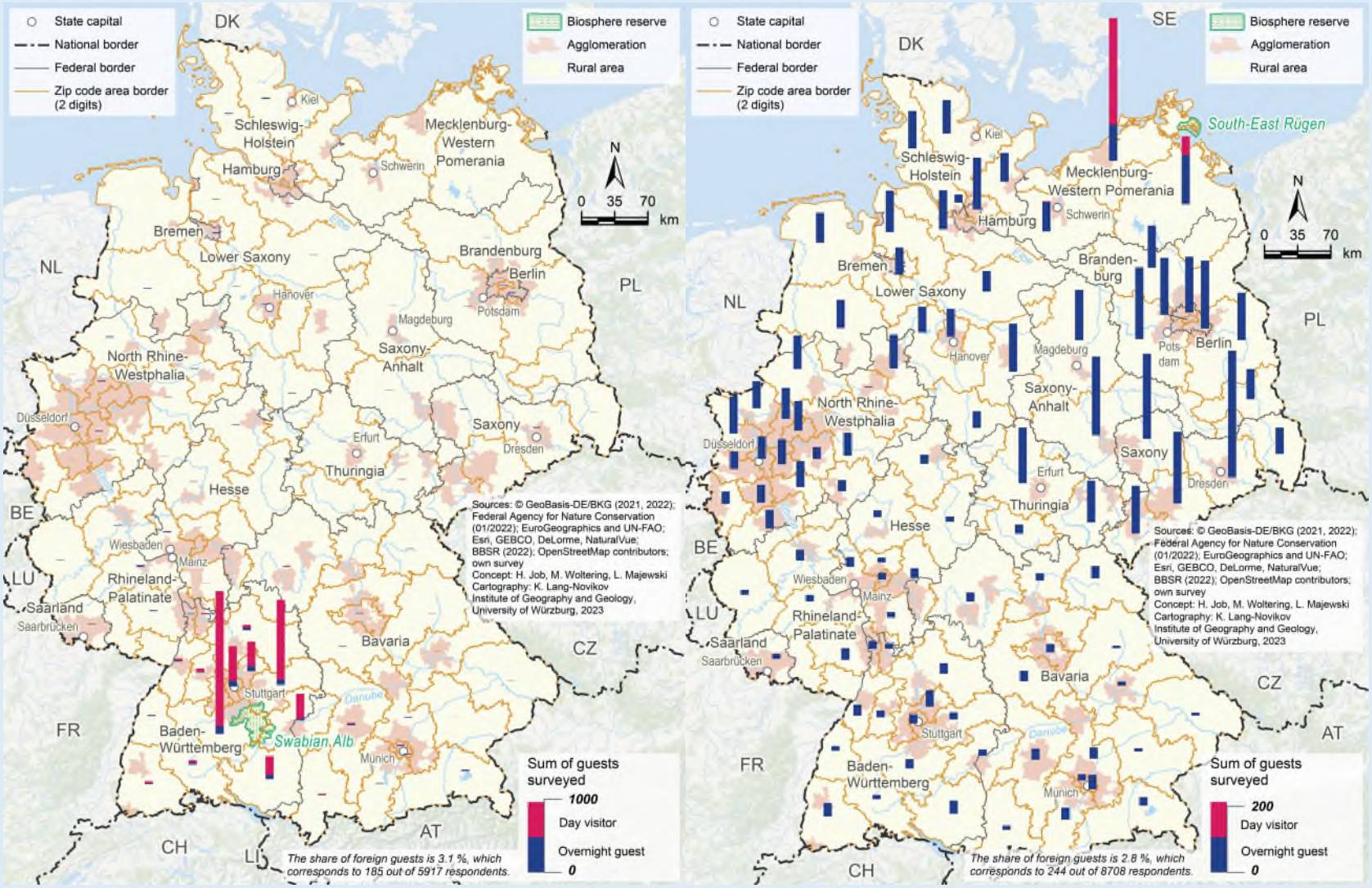


Table 3: Visitor days and structures

Biosphere reserve	Visitor days	Day visitors	Overnight guests	Day visitor share [%]	Overnight guest share [%]	Area size [ha]	Visitor density [visitor days/ha]
Berchtesgadener Land	7,419,000	3,762,000	3,657,000	50.7	49.3	83,984	88.3
Black Forest	4,030,000	1,729,000	2,301,000	42.9	57.1	63,236	63.7
Bliesgau	3,887,000	3,246,000	641,000	83.5	16.5	36,152	107.5
Drömling	319,500	277,000	42,500	86.7	13.3	45,370	7.0
Elbe River Landscape	2,597,000	1,528,000	1,069,000	58.8	41.2	282,250	9.2
Hamburg Wadden Sea	59,000	41,000	18,000	69.5	30.5	11,700	201.2**
Lower Saxony Wadden Sea	21,745,000	2,020,000	19,725,000	9.3	90.7	240,000	1,138.0**
Palatinate Forest	5,715,000	3,460,500	2,254,500	60.6	39.4	178,496 (177,842*)	32.1***
Rhön	6,370,000	4,335,000	2,035,000	68.1	31.9	243,323 (185,210*)	34.4***
Schaalsee	490,000	404,000	86,000	82.4	17.6	31,000	15.9
Schleswig-Holstein Wadden Sea and Halligen****	520,000	259,000	261,000	49.8	50.2	444,935	89.0**
Schorfheide-Chorin	3,202,000	2,235,000	967,000	69.8	30.2	129,161	24.8
South-East Rügen	5,288,000	355,000	4,933,000	6.7	93.3	22,800 (11,100*)	476.9***
Southern Harz Gypsum Karst Region	227,500	130,500	97,000	57.4	42.6	30,034	7.6
Spree Forest	1,943,000	946,500	996,500	48.7	51.3	47,509 (47,509*)	40.9***
Swabian Alb	7,124,000	5,735,000	1,389,000	80.5	19.5	85,269	83.5
Thuringian Forest	487,000	312,000	175,000	64.1	35.9	33,672 (17,081*)	28.5***
Upper Lausitz Heath and Pond Landscape	166,000	128,000	38,000	77.1	22.9	30,102	5.5
Sum/average	**71,589,000**	**30,903,500**	**40,685,500**	**59.3**	**40.7**	**2,216,124**	**132.9**

* area at the time of the surveys ** based on the terrestrial area *** based on the area before area expansion **** based on the development zone of Halligen and Pellworm Island

4 Visitor survey and expenditure

4.1 Questionnaire design

The survey instrument design (i.e., the questionnaire; Annex A and B) is crucial for achieving valid results. Questions need to be understandable, clear, and unambiguous. The questions asked in a visitor spending survey are relatively complex and require careful wording. The order of questions and their presentation should be considered. It is essential to obtain expert feedback on the draft questionnaire and, when possible, test the survey instrument using focus groups or a pilot study before implementing the full survey.

A well-designed questionnaire will ensure that every question asked fulfils its specific purpose in the analysis. The questions should allow analysts to:

- Split visitors into visitor segments that describe differences in spending patterns: Visitors are divided into sub-groups with different characteristics, such as international versus domestic visitors, people on overnight trips or day trips, or another category that may affect spending patterns (e.g., travelling independently or with a guided group).
- Develop visitor spending profiles to describe average expenditures made within biosphere reserves and surrounding regions for each visitor segment.
- Convert visitor count estimates and spending profiles into compatible units of measure. For example, if visitor counts are measured in visitor days, visitor spending profiles must also be calculated per visitor day. Similarly, if spending profiles are in terms of spending per party per day, visitation counts must be converted into party-days.
- Determine the portion of visitor spending attributable to the biosphere reserve.

4.2 Visitor spending estimation

Total visitor spending supported by visitation of a biosphere reserve is estimated by developing spending profiles that describe average expenditures made by visitors during their trip to a biosphere reserve. For most biosphere reserves, it is reasonable to estimate separate spending profiles for subgroups of visitors with distinct spending patterns (Stynes/White 2006). For example, visitors staying overnight in the area will likely have different spending patterns from those who only visit the area for a day (not paying for their accommodation; Huhtala et al. 2010; Mayer/Vogt 2016). For this reason, splitting visitors into day and overnight segments was suggested as a minimum segmentation strategy (Chapter 3.3).

Deciding which of these to count is very important because it must be linked to an appropriate spending profile (such as the average spending per visit, visitor or visitor day). To illustrate some of the considerations:

- Spending by entrants can vary widely because (a) they include non-recreational visitors whose spending is not considered in the economic analysis for tourism and (b) visits by entrants lasting only a few minutes that tend to have lower average spending than visits lasting several days.
- Locals need to be separated from day visitors. Biosphere reserves include, among other things, settlements where people live and go about their daily consumption habits. Locals do not play a role in the economic impact from outside.
- Distinguishing between day visits and overnight stays is necessary because overnight stays

tend to generate higher mean spending because of accommodation costs and associated purchases over longer time periods.

In the questionnaire, visitors should be asked to report their spending in the biosphere reserve with total expenditures split into a set of spending categories. There are two purposes for asking for spending by spending categories:

- Categories can help to prompt visitors to recall what they have spent money on during their trip to the local area.
- Spending categories are necessary to allocate spending to different economic sectors (which is important for estimating total economic effects).

Spending categories should reflect the types of goods and services that visitors may purchase while visiting the biosphere reserve. Typically, spending categories will include spending on accommodation (e.g., hotels, camping), food and drink (e.g., restaurants and bars, groceries), tours, activities and entertainment, souvenirs, transportation (e.g. taxis, buses, bike hire), and other context-specific spending categories (Stynes/White 2006). It is reasonable to exclude durable goods, such as purchases of equipment, boats, and vehicles, from trip expenditures because these expenditures represent goods that are used for more than a single visit to a biosphere reserve. Travel costs incurred outside of the local area (such as airfares and fuel costs) are typically excluded, too, as they do not contribute to the local area economy.

Visitor spending distributions typically follow a positively skewed distribution, where most visitors have relatively low or moderate spending, and a small number of visitors have very high spending. The high spenders can substantially affect spending averages, pulling the spending average well above median expenditures. Although average spending profiles do not represent what most visitors spend, average spending is the most appropriate figure to estimate total visitor spending. Total biosphere reserve visitor spending is estimated by multiplying the average visitor spending profiles by segmented visitor count data to calculate total spending by spending category.

Visitors may come to a local area to visit a biosphere reserve and to do other things as well (e.g., for a business trip, to visit friends or relatives or to enjoy other local attractions). These are called multi-purpose trips. **For both economic contribution and impact analyses, only spending associated with the biosphere reserve visit should be included as biosphere reserve visitor spending**. One approach to address multi-purpose trips is to allocate only the portion of trip expenditures associated with time spent visiting the biosphere reserve (instead of using spending associated with the full time in the local area). Consequently, the survey questionnaire must also include a question about the time spent within the respective biosphere reserve (Cullinane Thomas et al. 2019).

As described in Chapter 2, **economic impact analyses assess the impact of a biosphere reserve designation and consider the share of visitors and spending brought into the region because of the existence of the biosphere reserve**. Only the respondents stating that the biosphere reserve designation influenced their decision to come to the local area (i.e., **visitors with a high affinity for the biosphere reserve**) are included in the economic impact analysis.

4.3 Inflation adjustment of visitor spending in Germany's UNESCO biosphere reserves

The surveys in Germany took place within twelve years (2010 to 2021). Due to annual increases in consumer prices, the daily expenditures from the biosphere reserves are not per se comparable with each other. The development of consumer prices was considered, and the tourism spending values of all biosphere reserves investigated from 2010 onwards were adjusted to the annual price inflation to enable a comparison of the expenditure values. 2019 was chosen as the base year of the price development, when no economic consequences of the then-following Covid-19 pandemic nor the price increase due to the war against Ukraine had occurred. The expenditure values of areas studied after 2019 were accordingly back calculated.

The national consumer price index from 2010 to 2021 from official statistics was used as the data basis for developing consumer prices (Statistisches Bundesamt 2023). The change in the consumer price index was assumed as a proxy for the annual inflation rate of consumed goods and services. It is important to note that the consumer price index is only available at the federal level, and regional differences in price developments cannot generally be shown.

The tourism industry is characterized by various industries offering tourist goods and services on-site, which visitors have come to expect from the biosphere reserves. For official statistics, economic sectors are defined from the supply side, while no suitable economic sector can be identified due to the demand-side definition of tourism (Statistisches Bundesamt 2008). For the inflation adjustment of tourism expenditures in the biosphere reserve regions, the expenditure categories from the questionnaire were therefore assigned to the statistical purpose of individual consumption.

Official statistics publish the purposes of individual consumption down to a very detailed 5-digit level enabling a precise allocation of the expenditure categories. For example, expenditure on accommodation was adjusted for inflation based on the purpose of use for "overnight stays". For food, the average of the categories "food and non-alcoholic beverages" and "alcoholic beverages and tobacco products" was calculated. Non-food products, transport and others were also identified as cross-sectoral expenditure categories. The mean value was always calculated from the relevant indices in these cases. With the help of these change rates, the expenditure values for all biosphere reserves, differentiated according to visit segments, could be adjusted for inflation from their respective survey years to the base year 2019 (Job et al. 2016; Majewski 2023).

4.4 Results for Germany's UNESCO biosphere reserves

4.4.1 Affinity

The first question of the filter question sequence to operationalize visitors with a high affinity for the biosphere reserve (Chapter 2.3) asks for their knowledge about the protection status of the regions. The proportions vary between 7.8% for the Black Forest and 80.2% for the Swabian Alb (Figure 6). On average, 45.3% of the visitors are aware of the existence of the biosphere reserve within the region they have visited.

The average share of visitors with a high affinity for German biosphere reserves is 11.0 %. The shares vary between 0.7% in Black Forest and 21.5% in Schorfheide-Chorin and Schaalsee (see Figure 6). Overall, it is noticeable that the proportion of visitors with a high affinity for

the biosphere reserve is very low compared to the general knowledge about the protection status of the region as a biosphere reserve. This implies that while the biosphere reserve is acknowledged in the region, it plays a relatively insignificant role in influencing the decision to visit the area.

The highest affinity values, reaching 21.5% in the biosphere reserves Schorfheide-Chorin and Schaalsee, can be attributed to promoting these biosphere reserves as very young destinations with limited prior tourism traditions. This is especially evident in Schaalsee, where the UNESCO label significantly enhances the appeal of this relatively undiscovered tourism destination. Bliesgau, with an affinity of 18.1%; Upper Lausitz Heath and Pond Landscape, with 17.9%; Swabian Alb, with 14.6%; and Rhön, with 13.7%, owe their recognition to the efforts of the administrative offices and the corresponding external communication. In these regions, protection status is also more frequently correctly understood than the average (Figure 6). Drömling, the newest biosphere reserve in Germany, initially has a knowledge level below the average of 30.8%. However, it is noteworthy that this relatively lesser-known tourist destination still boasts a substantial biosphere reserve affinity of 12.8%.

Elbe River Landscape with 11.7%, Thuringian Forest with 11.1%, Spree Forest with 8.7%, and the Halligen with Pellworm with 8.6% rank in the middle. The Thuringian Forest and the Spreewald are important tourist brands even without the label as a biosphere reserve. As such, other attractions, such as the “Rennsteig” in the Thuringian Forest, or products, such as the “Spree Forest pickles”, are marketed to tourists. In the case of the Elbe River Landscape, its spatial extent along the Elbe river is decisive, which is recognized as a destination at best during cycling tours along the “Green Belt”. Instead, individual smaller regions along the Elbe are marketed for tourism and perceived as destinations, such as Lutherstadt Wittenberg or the UNESCO World Heritage Sites of the “Garden Kingdom of Dessau-Wörlitz”. The Halligen stand for a unique cultural landscape whose protection as a biosphere reserve is already recognized in parts. However, there is a market competition in this region due to the Schleswig-Holstein Wadden Sea National Park and the UNESCO World Heritage Site.

The lowest affinities show the biosphere reserves Berchtesgadener Land with 4.6%, Pfälzerwald with 3.5%, South-East Rügen with 4.9%, Southern Harz Gypsum Karst Region with 2.0% and Black Forest with 0.7%. In all these cases, this result implies to be influenced by well-established tourism regions or well-known national parks or nature parks in proximity, resulting in a minor role of the biosphere reserve as a tourism brand. For example, on Rügen Island, Jasmund National Park is recognized as a protected area, with a share of 27.5% of visitors having a high affinity for the national park. Berchtesgaden National Park accounts for 27.7% of visitors with a high affinity for the national park (Job et al. 2016). The lowest value in the Black Forest biosphere area can be attributed to the empirical analysis, which was conducted just at the time when this biosphere reserve was officially designated. Additionally, this lower value is a result of the biosphere reserve’s location within the well-known tourism destination of the Southern Black Forest Nature Park.

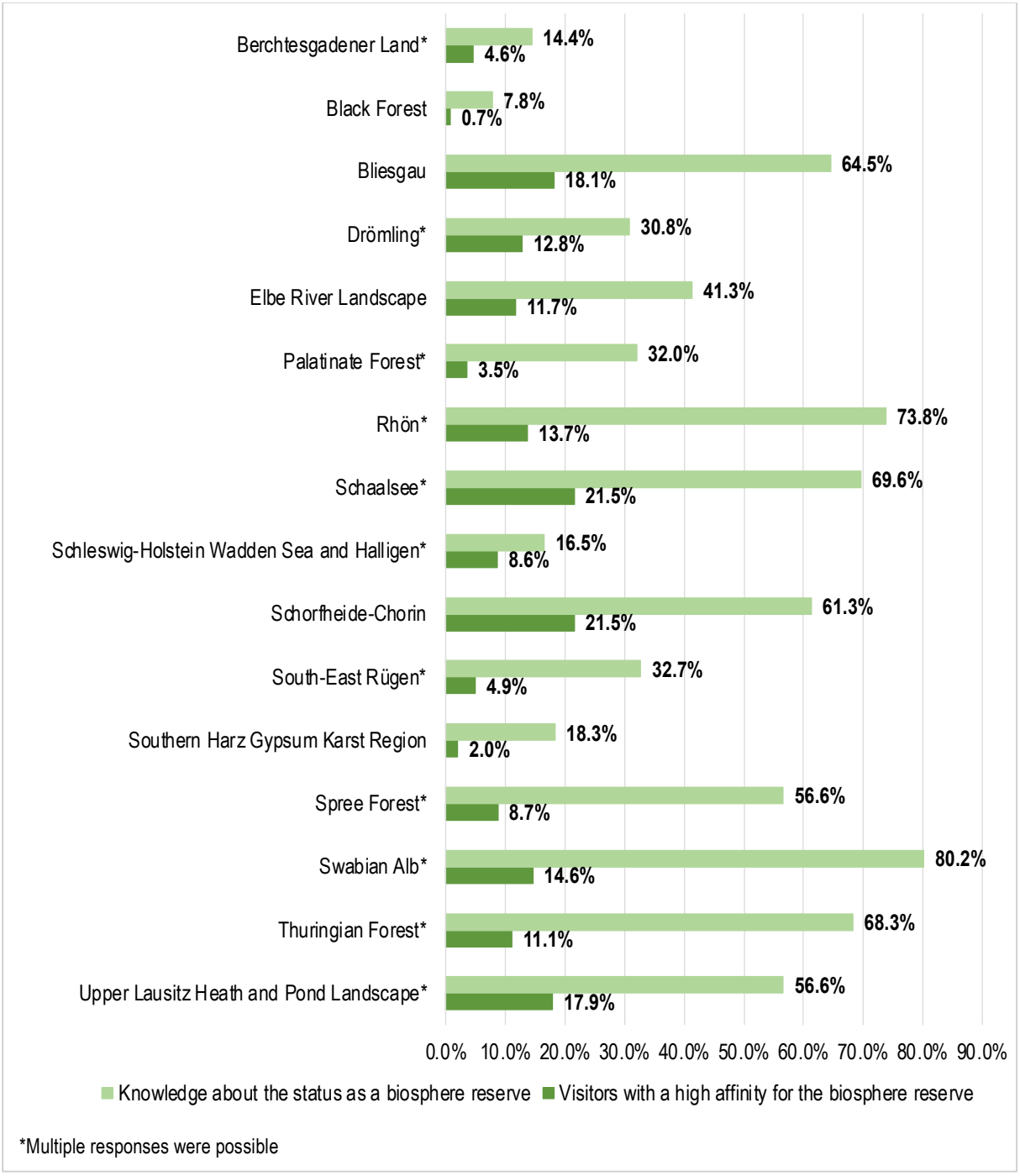


Figure 6: Nomination of the protection status as a biosphere reserve and share of visitors with a high affinity for the biosphere reserve.

The proportion of visitors with a high affinity for the biosphere reserve varies depending on the survey site. Factors such as the site's tourist brand and attraction function, the closeness to nature, the site's accessibility, or the leisure activities carried out there play a role. High-affinity values are achieved at information centres such as the information centre "Pahlhuus" in Schaalsee Biosphere Reserve (35.6 %), the "Blumberg Mill" in Schorfheide-Chorin (42.1 %) or the Biosphere Centre Swabian Alb (44.1 %). The recognition of the biosphere reserve is very low at thermal spas, which is not surprising since swimming, wellness, recreation, and health are the most important tourist motives there. The same applies, for example, to the Baltic Sea resort Baabe on the island of Rügen, where health-oriented spa holidays are important. At the castle church in Lutherstadt Wittenberg, it is mainly people motivated by cultural tourism who are encountered.

No biosphere reserve affinity was estimated for Lower Saxony and Hamburg Wadden Sea. At the time of the surveys, the areas of the respective national parks and biosphere reserves were almost identical, which is why no representative statements can be made about the role of the biosphere reserve as a tourism destination. The Halligen within Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserve, on the other hand, define a definable biosphere reserve destination (together with the island of Pellworm), which is why it was possible to operationalize a subgroup of visitors with a high affinity for the biosphere reserve for this area.

4.4.2 Visitor characteristics

Sociodemographic characteristics

The average age of biosphere reserve visitors is 47.1 years (see Table 4), which is slightly above the average age of the German population of 44.7 years (Statistische Ämter des Bundes und der Länder 2023; record date: 31.12.2021). The differences between the individual areas are interesting in this context, as the range of results extends from 42.3 years in the Schorfheide-Chorin Biosphere Reserve to 53.5 years in the Drömling Biosphere Reserve. To some extent, these differences can be explained by the location of the areas in the region. For example, the comparatively youngest visitors in Schorfheide-Chorin Biosphere Reserve are certainly mainly due to the geographical proximity to the greater Berlin area, from where most visitors depart. With an average age of 42.6 years, the capital city is characterized by a young population (Statistische Ämter des Bundes und der Länder 2023), which is not unusual for many cities in Germany. In contrast, biosphere reserves with a relatively high average age tend to be in peripheral areas, demographically more characterized by out-migration and an ageing population (Gehrlein et al. 2016; Job et al. 2019). Most visitors to Drömling and Elbe River Landscape, for example, come from Saxony-Anhalt, where the average age of the population is 48.1 years, the highest in Germany (Statistische Ämter des Bundes und der Länder 2023).

The distribution of female and male visitors across all biosphere reserves almost corresponds to the distribution within the German population, with **50.8% female visitors to German biosphere reserves** (see Table 4) compared to 50.7% proportion of women in Germany. The proportion of female visitors in national parks is slightly higher at 52.3% (Job et al. 2016).

Regarding the formal education of the biosphere reserve visitors, a **dominance of higher educational qualifications** is noticeable (see also Table 4). The proportion of visitors with a higher education entrance qualification is almost always at least half of all respondents. Peak values of over sixty percent are found in the biosphere reserves Hamburg Wadden Sea with 65.8%, Schleswig-Holstein Wadden Sea and Halligen with 64.4%, Schorfheide-Chorin with 71.4% and Black Forest with 64.8%. Compared to the national average, visitors to German

biosphere reserves are above averagely well educated because, throughout Germany, slightly more than one-third of the population has a higher education entrance qualification (35.7%; Statistisches Bundesamt 2023). The high level of formal education is also reflected in the high proportion of visitors with a degree: the Schorfheide-Chorin Biosphere Reserve is reaching the highest average with 62.3%, followed by the Thuringian Forest with 57.3% and the Elbe River Landscape with 50.0%. Most of the areas, however, have values between forty and fifty percent.

Most visitors are employees and civil servants, with an average of 58.3%, followed by pensioners and retirees at 25.3% and the self-employed at 10.7%. The group of pensioners in national parks is similarly high at 27.1% (Job et al. 2016). Drömling shows the highest age structure and proportion of pensioners at 44.5 % (see Table 4).

Trip-related characteristics

With an average of 80.3%, the car strongly dominates for travelling to a biosphere reserve (see Table 5). With values between eighty and ninety percent in most cases, this high significance of the car reveals the deficiencies in public transport, which is only used by an average of 5.1% of the visitors for their journey. This fact is unsurprising, considering that biosphere reserves are often situated in rural areas. Establishing efficient and attractive public transportation in these regions is frequently hindered by its financial challenges, resulting in relatively limited access to such services (Kagermeier/Gronau 2016; Majewski/Job 2019). The biosphere reserves Bliesgau with 22.0%, Drömling with 37.1%, Elbe River Landscape with 23.5% and Schleswig-Holstein Wadden Sea and Halligen with 36.6% show high values in the response category “other”, which is because of a significant preference for bicycles as the primary mode of transportation. Additionally, ferries are crucial for transportation to the Halligen and Pellworm within the Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserve.

For Drömling and the Elbe River Landscape, this result is confirmed by the highest shares of cyclists among the activity groups, with 46.0% and 35.4%, respectively (see also Table 5). In these two cases, it is unsurprising, as there are numerous well-developed cycling paths and a focus on marketing cycle tours to tourists. The biosphere reserves Upper Lausitz Heath and Pond Landscape and Schleswig-Holstein Wadden Sea and Halligen also show high averages of cyclists, with 30.9 % and 29.5 %, respectively. However, in most other areas, less than twenty percent, and in many cases, even less than ten percent, fall into the category of cyclists.

77.9% of the visitor movements are made on foot, either as part of a walk or a hike. The biosphere reserves Southern Harz Gypsum Karst Region (98.3%), Palatinate Forest (93.3%) and Schorfheide-Chorin (91.5%) have the highest averages for activities on foot. Furthermore, some seasonal or area-specific concentrations in the activities can be identified. For example, the biosphere reserves Spree Forest and South-East Rügen are characterized by a substantial proportion of visitors undertaking various water-related activities. In Spree Forest, boat trips, kayaking and canoeing are essential, while in South-East Rügen, bathers are a significant visitor group due to the classic seaside resorts in this area. In the biosphere reserves Berchtesgadener Land, Rhön, Swabian Alb, Black Forest and Thuringian Forest, skiing and cross-country skiing and tobogganing are exercised in winter. In Berchtesgadener Land, tobogganing and alpine skiing are more common, while Nordic skiing plays a role in the Swabian Alb and the Rhön because of the natural landscape.

On average, **the visitor groups comprise three persons**. In all German biosphere reserves, either couples of only two people or families with one or often several children are found.

Hotels comprise the largest share of the accommodation type chosen by overnight guests, with an average of 30.9% in all German biosphere reserves (see Figure 7 and Table 6). The highest values are registered in the biosphere reserves Hamburgisches Wattenmeer at 62.4%, Karstlandschaft Südharz at 49.2%, and Thüringer Wald at 47.8%. At 27.6%, overnight stays in holiday flats or houses are similarly significant, reflecting the accommodation structures in rural areas. At the Lower Saxon Wadden Sea and on the Halligen and Pellworm, these accommodation types clearly dominate over hotels, making up approximately two-thirds of all overnight stays. In the biosphere reserves Berchtesgadener Land, Upper Lausitz Heath and Pond Landscape, Schaalsee, Schorfheide-Chorin, Swabian Alb and Südost-Rügen, holiday flats and houses are chosen as the majority overnight accommodation option, too. The pension follows with an average for all German biosphere reserves of 10.1%. In Spree Forest and Palatinate Forest-North Vosgaes, for example, this accommodation type accounts for about twenty percent of overnight stays. Camping accounts for an average for all German biosphere reserves of 9.7%. In addition to these overnight stays in (non-)commercial establishments, visits to friends or relatives also play a major role in some areas, with an average of 11.0%. In Bliesgau, for example, private overnight stays account for more than one quarter, followed by the Swabian Alb and Drömling biosphere reserves with approximately twenty percent.

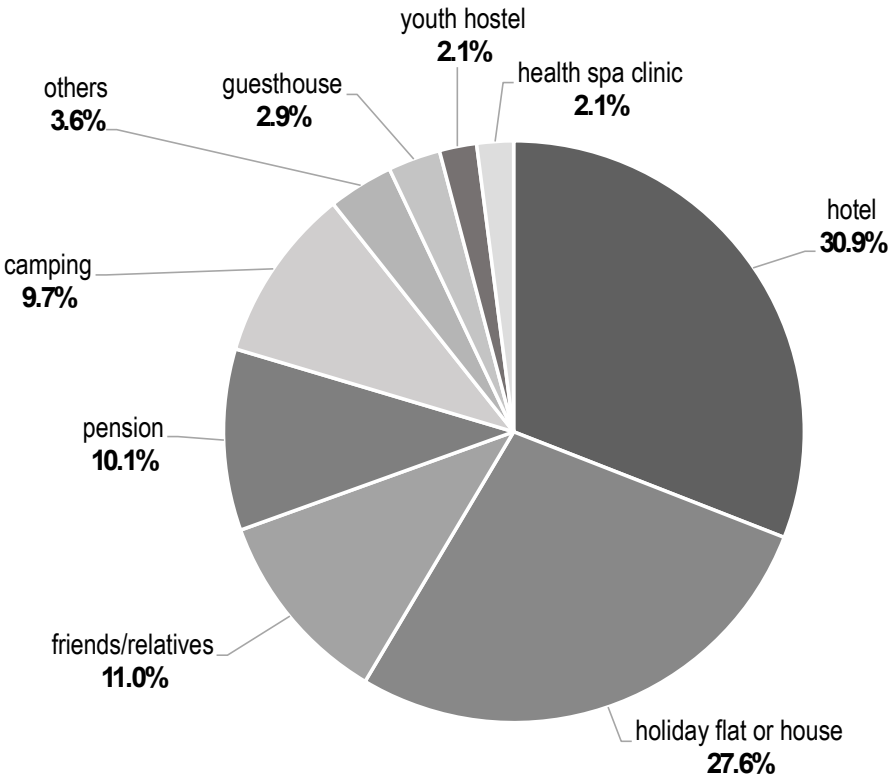


Figure 7: Type of accommodation

On average, overnight guests stay 5.3 nights in German biosphere reserves. The coastal biosphere reserves Lower Saxony Wadden Sea, Schleswig-Holstein Wadden Sea and Halligen, and South-East Rügen stand out as classic holiday regions with the longest stays of more than eight nights. The longest stays in terrestrial biosphere reserves are recorded in Bliesgau, Berchtesgadener Land and Schaalsee. The average length of stay in the biosphere reserves Elbe River

Landscape, Southern Harz Gypsum Karst Region and Drömling, on the other hand, is not even four nights. However, in most of the other terrestrial areas, overnight guests stay four to five nights.

Regarding the frequency of visits by overnight guests, the German biosphere reserves have a **loyal group of followers**. Many overnight guests already visited the biosphere reserve several times. Only about every third guest surveyed was encountered on his or her first holiday stay, while the majority had mostly between two and ten visits. Many biosphere reserves achieve values between twenty and thirty percent of guests who stayed in the biosphere reserve more than ten times. The Lower Saxony Wadden Sea Biosphere Reserve is an outlier because almost two-thirds of all overnight guests surveyed fall into the category of more than ten visits, which again explains its position as a traditional tourism destination.

Table 4: Sociodemographic characteristics

Biosphere reserve	Average age	Gender [%]		School graduation [%]					Degree [%]	Professional group [%]				
		female	male	In school education	No school graduation	Lower school leaving graduation	Intermediate school leaving graduation	Higher school leaving graduation		Self-employed	Employees, civil servants	in professional training	Retiree, pensioner	Others
Berchtesgadener Land	46.7	52.3	47.7	0.0	0.0	11.9	28.2	59.9	44.6	9.7	62.5	6.1	20.9	0.8
Black Forest	43.0	49.4	50.6	0.2	0.2	9.0	25.8	64.8	48.9	11.4	62.4	5.4	17.6	3.2
Bliesgau	45.9	52.7	47.3	0.3	0.3	15.6	26.8	57.0	42.8	11.1	57.3	4.7	25.2	1.7
Drömling	53.5	45.7	54.3	0.0	0.4	16.8	34.6	48.2	39.7	6.4	45.5	2.0	44.5	1.6
Elbe River Landscape	52.1	50.6	49.4	0.3	0.3	10.6	32.1	56.7	50.0	11.2	53.3	3.3	30.4	1.8
Hamburg Wadden Sea	47.2	56.3	43.7	0.3	0.0	10.1	23.8	65.8	45.7	11.2	63.0	4.6	20.8	0.4
Lower Saxony Wadden Sea	43.3	55.8	44.2	0.1	0.0	13.7	27.5	58.7	43.7	11.5	59.6	3.7	24.1	1.1
Palatinate Forest*	47.0	48.4	51.6	0.0	0.0	20.6	26.8	52.6	42.1	-	-	-	-	-
Rhön*	47.2	46.5	53.5	0.2	0.8	20.4	29.0	49.6	43.8	-	-	-	-	-
Schaalsee*	51.2	51.2	48.8	0.2	0.0	14.6	34.5	50.7	44.0	-	-	-	-	-
Schleswig-Holstein Wadden Sea and Halligen	46.0	52.3	47.7	1.3	0.0	7.2	27.1	64.4	44.3	8.7	57.4	5.1	26.1	2.7
Schorfheide-Chorin	42.3	52.6	47.4	0.8	0.0	2.8	25.0	71.4	62.3	15.3	59.6	4.1	19.8	1.2
South-East Rügen*	47.7	53.1	46.9	0.3	0.0	15.3	31.7	52.7	46.0	-	-	-	-	-
Southern Harz Gypsum Karst Region	49.7	47.4	52.6	0.3	0.0	10.1	40.8	48.8	44.7	9.0	57.7	1.3	30.3	1.7
Spree Forest*	47.3	50.4	49.6	0.6	0.2	9.0	35.8	54.4	47.7	-	-	-	-	-
Swabian Alb	43.3	51.8	48.2	0.5	0.0	13.6	28.1	57.8	45.0	11.7	63.5	3.7	18.6	2.5
Thuringian Forest*	50.5	46.9	53.1	0.1	0.0	8.9	32.6	58.4	57.3	-	-	-	-	-
Upper Lausitz Heath and Pond Landscape	43.6	50.1	49.9	0.1	0.1	10.3	39.9	49.6	38.7	11.0	58.2	2.3	25.5	3.0
Average	**47.1**	**50.8**	**49.2**	**0.3**	**0.1**	**12.3**	**30.6**	**56.7**	**46.2**	**10.7**	**58.3**	**3.9**	**25.3**	**1.8**

* in the first study, the profession was not recorded

Table 5: Trip-related activities: Mode of transport, activities, group size

Biosphere reserve	Mode of transport [%]			Activities [%]*				Average group size
	Car	Public transport	Others	Walkers/hiker	Cyclists/mountain biker/E-bike riders	Bather/water sports enthusiasts/mudflat walkers	Others	
Berchtesgadener Land	86.8	4.2	9.0	81.3	10.8	0.1	7.8	2.2
Black Forest	84.7	7.5	7.8	88.2	6.2	0.0	5.6	3.2
Bliesgau	76.3	1.7	22.0	81.8	17.5	0.3	0.4	2.3
Drömling	59.2	3.7	37.1	53.0	46.0	0.0	1.0	2.0
Elbe River Landscape	67.5	9.0	23.5	63.6	35.4	0.4	0.6	3.2
Hamburg Wadden Sea	77.8	9.5	12.7	91.4	3.2	5.4	0.0	3.4
Lower Saxony Wadden Sea	84.4	11.6	4.0	81.2	14.8	4.0	0.0	2.6
Palatinate Forest	81.8	3.6	14.6	93.3	4.8	0.5	1.4	2.9
Rhön	85.1	3.3	11.6	90.8	3.7	0.8	4.7	3.6
Schaalsee	88.9	0.9	10.2	79.1	15.3	3.7	1.9	3.1
Schleswig-Holstein Wadden Sea and Halligen	54.4	9.0	36.6	70.4	29.5	0.1	0.0	3.4
Schorfheide-Chorin	83.5	5.7	10.8	91.5	7.7	0.2	0.6	3.4
South-East Rügen	84.2	11.7	4.1	71.4	17.3	11.2	0.1	2.8
Southern Harz Gypsum Karst Region	88.2	1.1	10.7	98.3	1.7	0.0	0.0	3.7
Spree Forest	82.4	3.4	14.2	51.0	24.5	24.0	0.5	3.3
Swabian Alb	84.9	1.1	14.0	83.4	9.0	1.7	5.9	3.2
Thüringer Wald	87.0	4.7	8.3	74.1	9.0	0.0	16.9	2.8
Upper Lausitz Heath and Pond Landscape	87.9	0.8	11.3	59.4	30.9	3.4	6.3	3.3
Average	**80.3**	**5.1**	**14.6**	**77.9**	**16.0**	**3.1**	**3.0**	**3.0**

* analysis of the counts and short interviews

Table 6: Trip-related activities of the overnight guests: Accommodation type, length of stay, number of visits

Biosphere reserve	Accommodation type [%]									Average length of stay	Number of visits [%]		
	Hotel	Guest-house	Pension	Holiday flat or house	Health spa clinic	Youth hostel	Camping	Friends/relatives	Others		First visit	Up to 10	More than 10
Berchtesgadener Land	34.6	2.8	11.0	35.1	1.4	1.4	6.8	5.1	1.8	6.5	35.8	47.6	16.6
Black Forest	33.1	4.2	7.4	27.7	3.8	4.4	8.2	9.6	1.6	4.2	28.9	44.9	26.2
Bliesgau	29.2	1.3	2.9	18.6	8.2	5.9	5.2	27.4	1.3	7.4	52.9	27.1	20.0
Drömling	25.2	5.6	8.0	10.0	5.1	0.0	14.5	18.7	12.9	3.9	48.8	26.8	24.4
Elbe River Landscape	36.0	2.2	12.6	12.2	1.0	4.6	15.7	13.9	1.8	3.5	41.7	40.1	18.2
Hamburg Wadden Sea	62.4	0.6	7.1	0.7	0.0	2.0	9.7	2.1	15.4	4.0	26.3	38.9	34.8
Lower Saxony Wadden Sea	20.5	0.1	4.9	62.4	1.3	1.0	4.9	2.8	2.1	8.1	10.1	26.6	63.3
Palatinate Forest	34.8	8.4	18.5	13.4	1.0	3.5	8.6	10.8	1.0	4.0	33.7	42.0	24.3
Rhön	32.4	8.0	11.7	20.1	2.5	6.2	6.8	9.0	3.3	4.9	33.8	38.4	27.8
Schaalsee	12.9	3.5	5.9	32.1	1.5	0.3	19.1	17.8	6.9	6.5	33.5	44.7	21.8
Schleswig-Holstein Wadden Sea and Halligen	13.6	0.1	6.8	66.9	3.3	0.3	0.2	4.5	4.3	8.9	24.6	44.4	31.0
Schorfheide-Chorin	21.8	0.3	6.9	28.4	0.3	1.7	20.6	13.4	6.6	4.0	32.8	38.9	28.3
South-East Rügen	33.1	0.6	9.9	46.5	1.6	0.3	4.5	2.2	1.3	8.0	29.2	51.5	19.3
Southern Harz Gypsum Karst Region	49.2	2.7	10.4	23.1	0.3	1.7	2.6	8.9	1.1	3.8	29.2	46.1	24.7
Spree Forest	27.7	4.4	23.3	17.9	1.1	3.1	18.9	3.5	0.1	4.4	35.4	51.7	12.9
Swabian Alb	17.2	4.5	6.8	30.8	3.6	0.4	14.9	20.4	1.4	5.1	33.0	32.0	35.0
Thüringer Wald	47.8	2.8	12.6	24.4	0.0	0.0	1.0	10.9	0.5	4.8	21.0	45.3	33.7
Upper Lausitz Heath and Pond Landscape	25.0	0.5	14.7	27.2	1.1	0.5	13.1	16.3	1.6	4.1	22.2	47.9	29.9
Average	**30.9**	**2.9**	**10.1**	**27.6**	**2.1**	**2.1**	**9.7**	**11.0**	**3.6**	**5.3**	**31.8**	**40.9**	**27.3**

* analysis of the counts and short interviews

4.4.3 Visitor spending

On average, day visitors spend € 21.60 and overnight guests € 70.00 per person per day in a German biosphere reserve (see Table 7). Among **day visitors**, the highest spending is observed at the Halligen or Pellworm Island in the Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserve, where day visitors spend € 42.70 per day. For a day trip to Neuwerk Island in the Hamburg Wadden Sea Biosphere Reserve, visitors spend € 38.50 on average. The high values are primarily due to spending related to public transport, particularly ferry services for island access. The two areas on the North Sea coast are followed by Spree Forest with € 29.50 and the Lower Saxony Wadden Sea with € 29.00, where, as in the two other Wadden Sea regions, high expenses are incurred for boat or ferry trips and bicycle rentals. In Spree Forest, local transport such as boat and kayak tours contributes to the relatively high expenditure. In contrast, day visitors to Drömling have by far the lowest expenditures at just € 6.60. The Thuringian Forest Biosphere Reserve follows with € 12.90, the Upper Lausitz Heath and Pond Landscape with € 15.00 and the Southern Harz Gypsum Karst Region with € 16.00 (Figure 8).

Regarding **overnight guests**, the highest expenditure is € 94.20 for a stay in Berchtesgadener Land per person and day, followed by South-East Rügen with € 89.30 and the Palatinate Forest with € 88.20 (see Figure 8). In the case of the latter, the great importance of wine tourism on the German Wine Route with wine tasting and purchase plays a significant role. In the cases of Berchtesgadener Land and South-East Rügen, the high sums are influenced by their position as a traditional holiday region within Germany. The destinations offer a wide array of diverse and frequently fee-based activities and services. Additionally, it is worth noting that both regions exhibit a higher proportion of higher-priced hotel accommodations than the average. Generally, one can observe a significant impact of the available accommodation options on tourism expenditures across all German biosphere reserves. For instance, overnight guests in the Lower Saxony and Schleswig-Holstein Wadden Sea regions tend to choose more affordable holiday flats, resulting in lower daily expenditures within these biosphere reserves.

The lowest expenditure for overnight guests is registered in Drömling, with € 47.70. Schorfheide-Chorin is on the same level, with € 47.50 (see Figure 8). The lower values can be attributed to the ongoing destination development process in regions relatively little-known or unfamiliar to tourists. A similar situation can also be observed in the biosphere reserves Bliesgau, Upper Lausitz Heath and Pond Landscape, Schaalsee and Swabian Alb, where the expenditure from overnight guests is also in the low range between fifty and sixty euros. In all these areas, there is often a lack of established tourist offers, especially for accommodation, which means that potential income is lost. For example, at 27.4%, a large proportion of guests in Bliesgau stay overnight with friends or relatives, for which no expenditure is incurred. Except for Drömling, the holiday flat is the dominant type of accommodation in all the other regions just mentioned. The hotels mainly chosen in the Drömling are primarily in the lower price segment.

Regarding the **differentiation based on biosphere reserve affinity**, lower expenditure values are registered on average for both day and overnight visitors among visitors with a high affinity for the biosphere reserve compared to other visitors. However, the differences are marginal. Day visitors with a high affinity for the biosphere reserve spend, on average, € 19.60, which is slightly less than the € 20.00 spent by other day visitors. The differences between the two groups of overnight visitors are also small, amounting to € 66.90 for visitors with a high affinity for the biosphere reserve and € 68.70 for other visitors. Nevertheless, there are

differences depending on the area. In the biosphere reserves Bliesgau, Drömling, Upper Lausitz Heath and Pond Landscape, Schaalsee, Swabian Alb and Thuringian Forest, the daily spending of visitors with a high affinity for the biosphere reserve is higher than that of other visitors.

The spending patterns are very heterogeneous per region and depend on the spending category. For example, the spending behavior in Swabian Alb is due to additional expenditure in restaurants and retail products (e.g., clothing and shoes), while day visitors with a high affinity for the biosphere reserve in Thuringian Forest spend more on leisure activities (e.g., entrance fees) and other services (e.g., use of transport). In the case of overnight visitors, visitors with a high affinity for the biosphere reserve record higher expenditure in the regions Rhön, Schaalsee, Swabian Alb, Spree Forest and South-East Rügen, whereby mainly the hospitality industry profits there, with additional expenditure for accommodation and restaurants from visitors with a high affinity for the biosphere reserve. However, as mentioned earlier, in most cases, other visitors spend more during their stay.

To some extent, these variations in visitor structures reveal that biosphere reserve-specific nature tourism offers, which can specifically address visitors with a high affinity for the biosphere reserve, are still missing. The existing local tourism offers lack a clear connection to the biosphere reserve. Therefore, the differences in expenditure can currently be attributed more to the importance of the biosphere reserves within Germany's broader destination landscape, with diverse, high-priced offers in the well-known travel areas along the coast and in the Alpine region. **The expenditure differences are influenced less by the protected status of the biosphere reserves and more by the variety of tourism options available.**

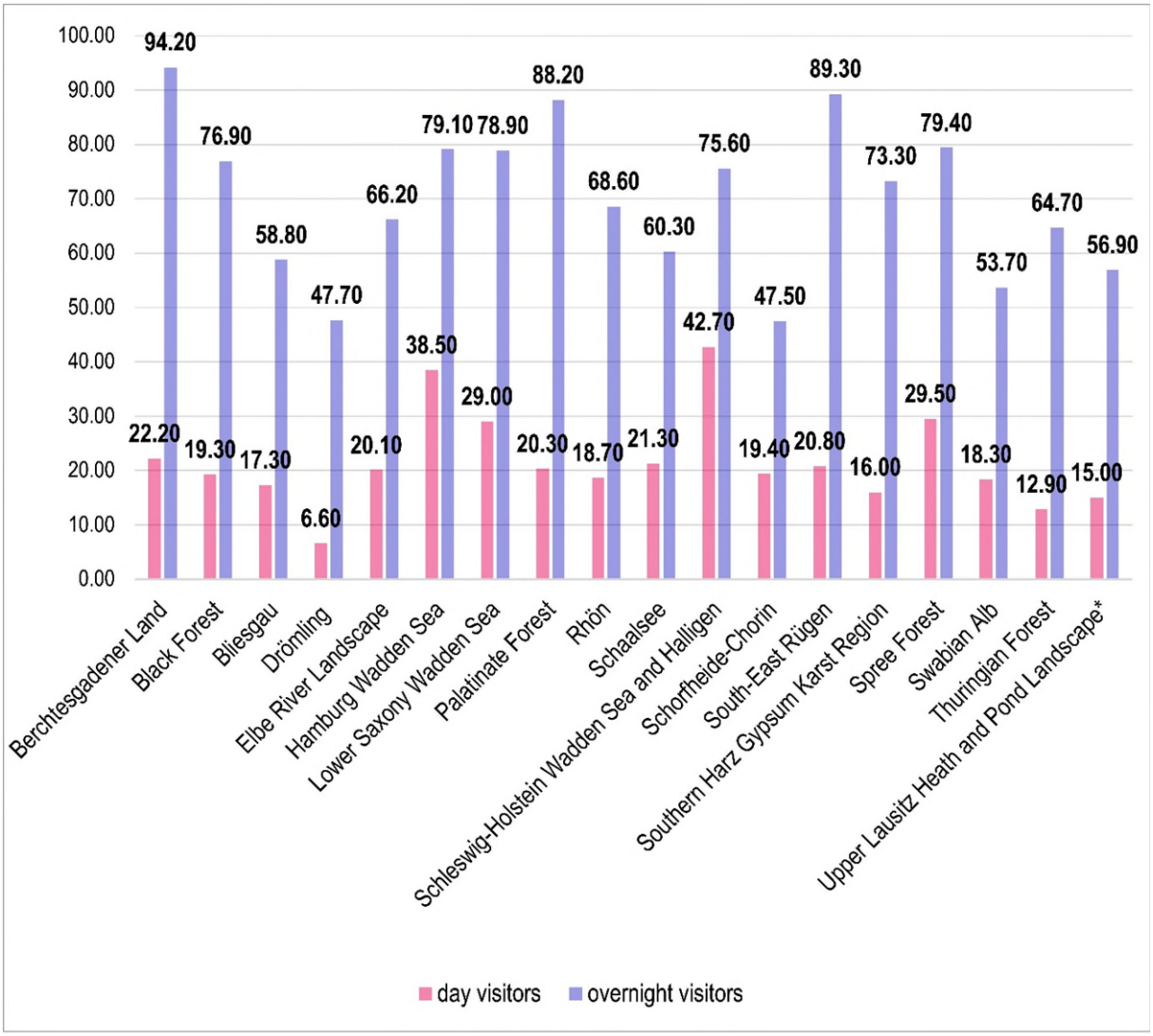


Figure 8: Average spending per person and day of day visitors and overnight guests (inflation adjusted; price year 2019)

Table 7: Average visitor spending for visitor types with and without inflation adjustment (price year 2019)

Biosphere reserve	Survey year	Without inflation adjustment [€]						With inflation adjustment (base year 2019) [€]					
		Day visitors			Overnight guests			Day visitors			Overnight guests		
		Visitors with a high affinity for the biosphere reserve	Other visitors	Total	Visitors with a high affinity for the biosphere reserve	Other visitors	Total	Visitors with a high affinity for the biosphere reserve	Other visitors	Total	Visitors with a high affinity for the biosphere reserve	Other visitors	Total
Berchtesgadener Land	2021/22	23.80*	23.80*	23.80	99.00*	99.00*	99.00	22.20*	22.20*	22.20	94.20*	94.20*	94.20
Black Forest	2018/19	19.30*	19.30*	19.30	76.90*	76.90*	76.90	19.30*	19.30*	19.30	76.90*	76.90*	76.90
Bliesgau	2016/17	16.50	16.20	16.30	46.70	55.90	55.20	17.60	17.10	17.30	49.80	59.60	58.80
Drömling	2020/21	7.30	6.90	6.90	49.70*	49.70*	49.70	6.90	6.50	6.60	47.70*	47.70*	47.70
Elbe River Landscape	2018	17.90	19.90	19.70	56.20	66.10	64.80	18.30	20.30	20.10	57.50	67.50	66.20
Hamburg Wadden Sea**	2019/20/21			39.30			82.00			38.50			79.10
Lower Saxony Wadden Sea**	2019/20			29.00			78.90			29.00			78.90
Palatinate Forest	2011/12	14.90	17.30	17.20	58.60	75.90	75.10	17.70	20.40	20.30	69.90	89.10	88.20
Rhön	2010/11	13.70	16.10	15.80	60.20	57.30	57.60	16.30	19.10	18.70	72.40	68.10	68.60
Schaalsee	2011/12	20.40	17.20	17.90	58.60	48.40	51.10	24.00	20.60	21.30	69.20	57.10	60.30
Schleswig-Holstein Wadden Sea and Halligen	2021/22	45.10*	45.10*	45.10	78.60*	78.60*	78.60	42.70*	42.70*	42.70	75.60*	75.60*	75.60
Schorfheide-Chorin	2017/18	17.20	19.00	18.60	42.50	46.50	45.50	17.90	19.80	19.40	44.40	48.50	47.50
South-East Rügen***	2011/12	-	17.20	17.20	76.50	75.60	75.60	-	20.80	20.80	90.90	89.30	89.30
Southern Harz Gypsum Karst Region	2017	15.40*	15.40*	15.40	66.60	70.40	70.30	16.00*	16.00*	16.00	69.50	73.40	73.30
Spree Forest	2011/12	15.40	25.20	24.70	67.70	67.00	67.00	18.30	30.10	29.50	80.30	79.30	79.40
Swabian Alb	2016/17	21.90	16.40	17.20	58.60	48.80	50.50	23.30	17.40	18.30	62.10	52.00	53.70
Thuringian Forest	2010/11	13.60	10.30	10.70	50.10	54.00	53.70	16.30	12.50	12.90	60.50	65.10	64.70
Upper Lausitz Heath and Pond Landscape	2016/17	16.30	13.70	14.10	46.00	54.70	53.40	17.40	14.50	15.00	49.00	58.30	56.90
Durchschnitt		**18.60**	**18.70**	**20.50**	**62.00**	**64.10**	**65.80**	**19.60**	**20.00**	**21.60**	**66.90**	**68.70**	**70.00**

* not differentiated due to insufficient number of cases **no biosphere reserve affinity was determined *** no day visitors with a high affinity for the biosphere reserve were identified

5 Economic analysis

5.1 Economic ratios and multipliers

Money that people spend during a visit to a biosphere reserve has multiple economic effects, such as generating employment, taxes, value added, and income. Economic ratios are used to translate visitor spending into these different effects. These effects occur within the tourism sector itself. Thus, economic ratios are used to find out how much direct employment, income, taxes, and value added are generated by visitor spending. Economic ratios show conversions between different economic activity measurement types (e.g., number of jobs /visitor spending). Using the example of value added, ratios can be calculated by dividing the total value added generated by visitor spending by the direct output of visitor spending:

$$\text{Value added ratio} = \frac{\text{Direct value added}}{\text{Direct output}}$$

The so-called value added ratio can be applied to the output of visitor spending to estimate the value added generated by the output:

$$\text{Direct value added} = \text{Value added ratio} \times \text{Direct output}$$

Even though economic ratios can be calculated using different denominators, tourism economic impact assessments are typically based on the direct output. The direct output is used to account for first-round leakage effects. It is calculated by multiplying the total sales (equaling the visitor spending) by a capture rate.

The size of the total economic effects depends on leakage respectively the capture rate. Money spent by visitors that is not retained locally is called a leakage. At the national level, only the leakages to foreign countries are of interest, while on a regional or local level of biosphere reserves, the share leaking out of the area is crucial. Leakages can be caused by payments made for imported goods (e.g., imported souvenirs, food, and drink), money that is transferred out of the region for government taxes, or profits that are transferred to companies based outside the region. Lower leakages mean that a greater proportion of tourism value added is retained in the region. By contrast, the term capture rate is the opposite of the leakage. It refers to the money captured, or retained, within the local economy when it is re-spent locally. The capture rate is the proportion of the total money spent in the region that stays in the region. For simplicity, the capture rate of 100% is often assumed for the service sector, as service sectors typically rely on few input goods. However, when applied to the retail sector, a capture rate of less than 100% is used, as imported goods purchased for resale are not included as supporting local business activity and are therefore not included in direct output estimates.

Multipliers are coefficients used to convert direct economic effects into the total economic effects (i.e., direct + indirect + induced economic effects). They describe the ripple effects of visitor spending on intermediate consumption (indirect) and private household consumption (induced), which means the secondary effects. Multipliers can be expressed in various ways to assess different types of indirect and induced economic effects such as value added, employment, taxes, or income. Such multipliers are then called value added multipliers or employment multipliers.

Two types of multipliers are used to estimate the secondary effects of visitor spending:

- Indirect economic effects are calculated by applying Type I multipliers to the direct economic effects. Type I multipliers are the ratio of the sum of direct and indirect effects to direct effects:

$$\text{Type I multiplier} = \frac{\text{Direct effect} + \text{Indirect effect}}{\text{Direct effect}}$$

- Induced economic effects are calculated by applying Type II multipliers to the direct economic effects. Type II multipliers are the ratio of the sum of direct, indirect, and induced effects to direct effects:

$$\text{Type II multiplier} = \frac{\text{Direct effect} + \text{Indirect effect} + \text{Induced effect}}{\text{Direct effect}}$$

Four factors influence the size of capture rates, leakage and multiplier effects:

1. The economic sector assessed: The capture rate varies between economic sectors based on the ratio of goods and services purchased within and outside the region. Therefore, different capture rates are applied to assess indirect effects (which depend on the specific structure of the input goods purchased by the tourism sector) and for the induced effects (which depend on the general demand of the population in the region).
2. The size of the area that the multiplier refers to; generally speaking, the larger the area, the larger the capture rate and the lower the leakages. This is because it is generally more likely that tourism products and services are purchased from a larger region.
3. The level of economic development and diversity of a region: The more products and services that are produced locally, the smaller the leakage will be, and the larger the multiplier will be.
4. The expenditure structure: If there is a higher proportion of locally produced products and services than those purchased from outside the region, there will be higher direct and indirect effects. This would strengthen the basic idea of a biosphere reserve by making the regional economy more sustainable in terms of a circular economy.

5.2 Value added analysis for estimating regional economic effects in Germany's UNESCO biosphere reserves

As mentioned above, value added analyses were conducted to calculate the regional economic effects of visitation in German biosphere reserves. This method is based on economic ratios on the direct and indirect effects level. The direct effect ratios are separated for the visitor spending categories. In contrast, a general ratio of 30% indirect value added of intermediate consumption is assumed to remain locally for the indirect effects. This ratio expresses the multiplier effect. Induced effects cannot be determined.

The multiplication of the number of visitor days, differentiated into visitor segments (day visitors and overnight guests as well as visitors with a high affinity for the biosphere reserve and other biosphere reserve visitors), with the average daily visitor spending (separated into spending categories) results in the tourism gross sales. After deducting industry-specific VAT rates, the net sales were calculated. The share of the value added remaining in the biosphere reserve region on the net sales per spending category, e.g., the direct value added, was

calculated by sector-specific value added ratios. They vary between 10% for grocery (a capture rate is used because imported goods purchased for resale are not included in the locally generated direct output; see Chapter 5.1) and 48% for services such as local transportation and leisure activities. The indirect value added is calculated by multiplying the remaining intermediate inputs by an average value of 30% (based on long-standing experience; Woltering 2012).

The sum of direct and indirect value added shows the total tourism value added. Regional employment effects are expressed by income equivalents. These are calculated by dividing the value added by the regional primary income per inhabitant of the statistically delimited biosphere reserve regions (all municipalities and administrative districts intersecting with the biosphere reserve). These data are published in the national accounts. For this purpose, the primary income per inhabitant was weighted proportionally according to the number of inhabitants per associated administrative district to provide regional precision. The result shows a fictitious number of persons who can earn their living through nature-based tourism in the biosphere reserve (including all non-employed persons and other household members to be provided for).

Furthermore, due to the twelve-year period between the first and last surveys, the inflation-adjusted expenditure values for the price year 2019 were used to calculate the regional economic effects of tourism. The statistical data on the private income of private households used for calculating the income equivalents were also updated for 2019 according to the 2019 revision of the national accounts of the German Länder. As a result, all regional economic indicators of gross and net sales, direct and indirect value added, and income equivalents refer to the base year 2019 and are thus comparable.

5.3 Results for Germany's UNESCO biosphere reserves: Regional economic effects

The 71.6 million visitor days in all 18 German biosphere reserves generate gross sales of € 3.84 billion. The highest gross sales are generated in the Lower Saxony Wadden Sea Biosphere Reserve region, with € 1.62 billion due to its above-average volume of total nature-based tourism demand. Besides this outlier on the North Sea coast, the two important tourism destinations of South-East Rügen, with € 448.32 million and Berchtesgadener Land, with € 428.01 million, are at similar gross sales levels (see Table 8). In all three cases mentioned before, the high gross sales depend on the above-average share of overnight guests, with a higher daily expenditure. Tourism in these very long-established destinations, with their diverse, fee-based offers, thus contributes significantly to regional development as an economic stimulus.

In contrast, little or unknown tourism destinations generate the lowest gross sales in a Germany-wide comparison due to the lower tourism demand volume and more local visitor structures. Among these areas, the Drömling, which has just been designated as a biosphere reserve in 2023, has the lowest gross sales of € 3.84 million in the ranking of German biosphere reserves, followed by the Upper Lusatian Heath and Pond Landscape with 4.07 million €. In these biosphere reserves, there is currently a fundamental lack of tourism offers to activate demand and thus also local tourism consumption, which results in a lack of economic impulses.

After deducting VAT of € 364.04 million, the total net sales throughout Germany's biosphere reserve network amount to € 3.48 billion. Nationwide biosphere reserve tourism generates

direct value added of € 1.32 billion and indirect value added of € 646.87 million. The 71.6 million visitor days in German biosphere reserves generate a tourism value added of € 1.97 billion. The regional employment effect amounts to an income equivalent of 77,419 persons.

The regional economic effects associated with the existence of biosphere reserves are lower overall. **The German biosphere reserves record 4.9 million visitor days of visitors with a high affinity for the biosphere reserve. This core group generates gross sales of € 174.13 million. After deducting VAT of € 18.61 million, this results in net sales of € 155.52 million. Visitors with a high affinity for the biosphere reserve generate a nationwide direct value added of € 55.68 million. The indirect value added amounts to a further € 29.95 million, resulting in a total of € 85.63 million.** Even the still young biosphere region Black Forest Biosphere Reserve, with its very low affinity or the very important tourism destination Berchtesgadener Land, where, however, the biosphere reserve also plays only a minor role in the perception of the visitors so far, contributes to the nationwide biosphere reserve-induced added value of tourism, the income equivalent amounts altogether to 3,320 persons (see Table 9). Figure 9 shows the nationwide visitor days and structures in German biosphere reserves as well as the income equivalents generated by visitors with a high affinity for the biosphere reserve and other biosphere reserve visitors.

Table 8: Regional economic effects of tourism in German biosphere reserves

Biosphere reserve	Visitor days	Proportion of day visitors [%]	Proportion of overnight guests [%]	Daily visitor spending per day visitor [€]	Daily visitor spending per overnight guest [€]	Gross sales [€]	VAT [€]	Net sales [€]	Direct value added [€]	Intermediate consumption [€]	Indirect value added [€]	Value added sum [€]	Income equivalent [persons]
Berchtesgadener Land	7,419,000	50.7	49.3	22.20	94.20	428,005,800	34,320,949*	393,684,851	148,879,732	244,805,119	73,441,536	222,321,268	7,880
Black Forest	4,030,000	42.9	57.1	19.30	76.90	210,316,600	21,161,183	189,155,417	72,476,358	116,679,059	35,003,718	107,480,076	3,249
Bliesgau	3,887,000	83.5	16.5	17.30	58.80	92,967,400	10,953,990	82,013,410	29,387,929	52,625,481	15,787,644	45,175,573	1,604
Drömling	319,500	86.7	13.3	6.60	47.70	3,838,950	297,606*	3,541,344	1,280,324	2,261,020	678,306	1,958,630	72
Elbe River Landscape	2,597,000	58.8	41.2	20.10	66.20	101,477,900	10,741,110	90,736,790	33,992,119	56,744,671	17,023,401	51,015,520	2,365
Hamburg Wadden Sea	59,000	69.5	30.5	38.50	79.10	2,999,400	262,260*	2,737,140	1,186,888	1,550,252	465,076	1,651,964	61
Lower Saxony Wadden Sea	21,745,000	9.3	90.7	29.00	78.90	1,615,161,617	139,665,509	1,475,496,108	577,212,124	898,283,984	269,485,195	846,697,319	34,126
Palatinate Forest	5,715,000	60.6	39.4	20.30	88.20	269,244,450	30,248,716	238,995,734	86,240,486	152,755,248	45,826,574	132,067,060	4,480
Rhön	6,370,000	68.1	31.9	18.70	68.60	220,614,500	24,952,782	195,661,718	70,181,936	125,479,782	37,643,935	107,825,871	3,953
Schaalsee	490,000	82.4	17.6	21.30	60.30	13,790,850	1,681,232	12,109,618	4,050,434	8,059,184	2,417,755	6,468,189	282
Schleswig-Holstein Wadden Sea and Halligen	520,000	49.8	50.2	42.70	75.60	30,790,900	3,187,079*	27,603,821	10,809,442	16,794,379	5,038,314	15,847,756	530
Schorfheide-Chorin	3,202,000	69.8	30.2	19.40	47.50	89,341,500	9,553,706	79,787,794	28,708,357	51,079,437	15,323,831	44,032,188	1,968
South-East Rügen	5,288,000	6.7	93.3	20.80	89.30	448,316,900	40,944,560	407,372,340	154,245,171	253,127,169	75,938,151	230,183,322	11,177
Southern Harz Gypsum Karst Region	227,500	57.4	42.6	16.00	73.30	9,196,490	942,256	8,254,234	3,195,509	5,058,725	1,517,618	4,713,127	257
Spree Forest	1,943,000	48.7	51.3	29.50	79.40	106,746,200	11,411,275	95,334,925	36,473,055	58,861,870	17,658,561	54,131,616	2,356
Swabian Alb	7,124,000	80.5	19.5	18.30	53.70	179,400,200	21,561,792	157,838,408	56,776,354	101,062,054	30,318,616	87,094,970	2,613
Thuringian Forest	487,000	64.1	35.9	12.90	64.70	15,363,300	1,687,771	13,675,529	5,021,166	8,654,363	2,596,309	7,617,475	352
Upper Lausitz Heath and Pond Landscape	166,000	77.1	22.9	15.00	56.90	4,070,100	464,747	3,605,353	1,260,700	2,344,653	703,396	1,964,096	94
Sum/average	**71,589,000**	**59.3**	**40.7**	**21.60**	**70.00**	**3,841,643,057**	**364,038,524**	**3,477,604,533**	**1,321,378,083**	**2,156,226,450**	**646,867,935**	**1,968,246,018**	**77,419**

* the reduced tax rates of the Corona tax aid laws were taken into account

Table 9: Regional economic effects of visitors with a high affinity for the biosphere reserve

Biosphere reserve	Visitors with a high affinity for the biosphere reserve [%]	Visitor days	Gross sales [€]	VAT [€]	Net sales [€]	Direct value added [€]	Intermediate consumption [€]	Indirect value added [€]	Value added sum [€]	Income equivalent [persons]
Berchtesgadener Land	4.6	338,000	14,415,600	1,250,179*	13,165,421	4,643,510	8,521,911	2,556,573	7,200,083	255
Bliesgau	18.1	698,000	15,698,000	1,908,668	13,789,332	4,425,196	9,364,136	2,809,241	7,234,437	257
Black Forest	0.7	30,000	1,097,400	120,804	976,596	373,548	603,048	180,914	554,462	17
Drömling	12.8	41,500	837,150	58,751*	778,399	275,779	502,620	150,786	426,565	16
Elbe Rinver Landscape	11.7	305,000	10,912,700	1,151,841	9,760,859	3,554,941	6,205,918	1,861,775	5,416,716	251
Palatinate Forest	3.5	201,000	8,882,100	969,497	7,912,603	2,588,946	5,323,657	1,597,097	4,186,043	142
Rhön	13.7	870,000	27,364,500	3,022,423	24,342,077	9,267,420	15,074,657	4,522,397	13,789,817	506
Schaalsee	21.5	106,500	3,573,000	414,493	3,158,507	1,033,066	2,125,441	637,632	1,670,698	73
Schleswig-Holstein Wadden Sea and Halligen	8.6	44,000	3,030,300	310,290*	2,720,010	1,057,642	1,662,368	498,710	1,556,352	52
Schorfheide-Chorin	21.5	688,000	18,383,700	1,944,173	16,439,527	5,631,772	10,807,755	3,242,327	8,874,099	397
Southeast-Rügen	4.9	260,000	23,634,000	2,093,423	21,540,577	8,414,746	13,125,831	3,937,749	12,352.495	600
Southern Harz Gypsum Karst Region	2.0	4,500	227,150	21,921	205,229	80,135	125,094	37,528	117,663	6
Spree Forest	8.7	168,500	9,004,550	959,125	8,045,425	3,092,714	4,952,711	1,485,813	4,578,527	199
Swabian Alb	14.6	1,040,000	34,755,200	4,122,952	30,632,248	10,526,096	20,106,152	6,031,846	16,557,942	497
Thuringian Forest	11.1	54,000	1,587,400	175,407	1,411,993	513,918	898,075	269,423	783,341	36
Upper Lausitz Heath and Pond Landscape	17.9	29,000	725,800	83,612	642,188	201,668	440,520	132,156	333,824	16
Sum/average	**11.0**	**4,878,000**	**174,128,550**	**18,607,559**	**155,520,991**	**55,681,097**	**99,839,894**	**29,951,967**	**85,633,064**	**3,320**

No biosphere reserve affinity was determined for Lower Saxony and Hamburg Wadden Sea and thus no regional economic effects for this segment.

* the reduced tax rates of the Corona tax aid laws were taken into account.

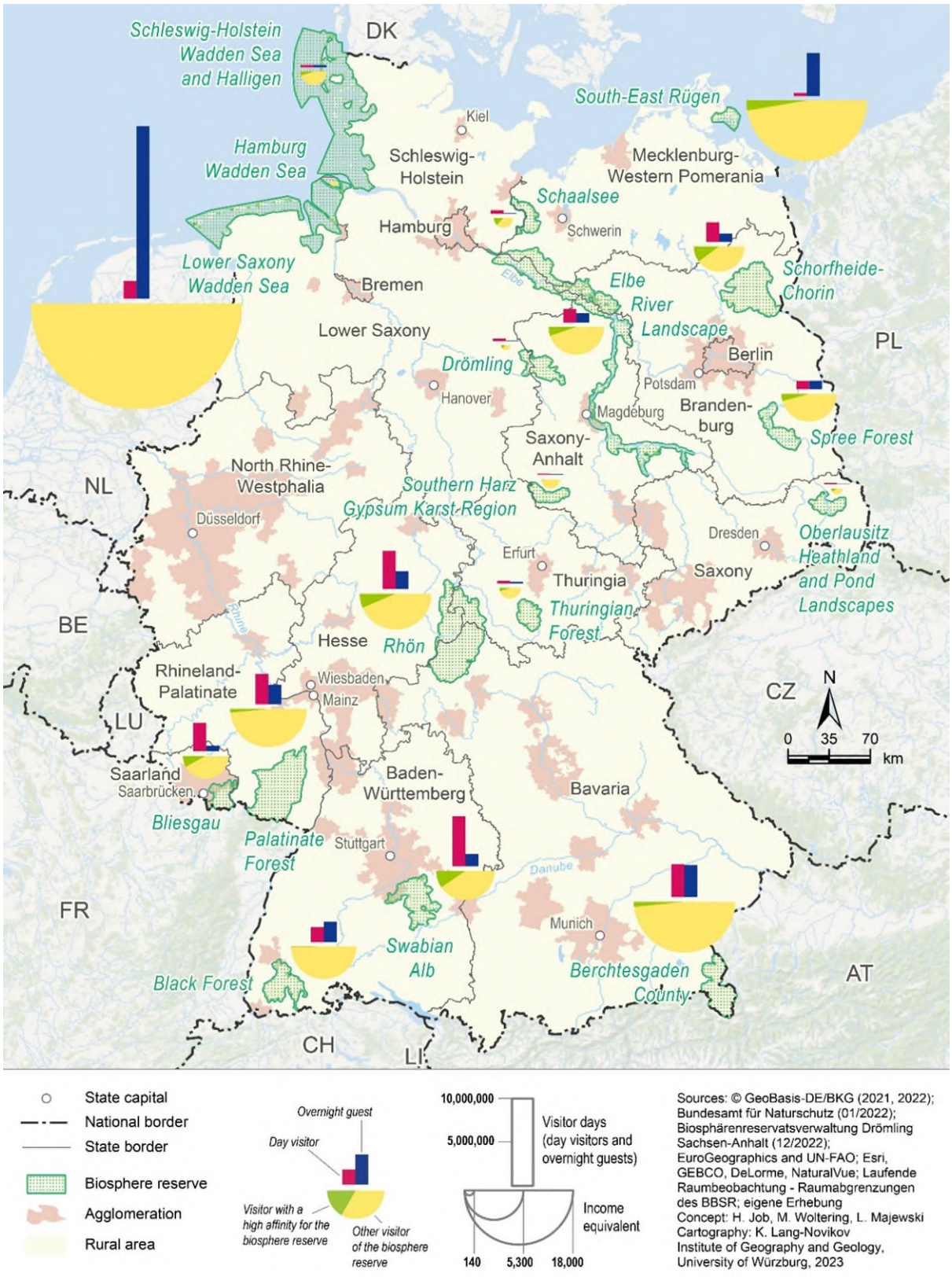


Figure 9: Visitor days, visitor structures and income equivalents in German biosphere reserves

5.4 Case study: Input-output analysis of Black Forest and Schleswig-Holstein Wadden Sea and Halligen Biospere Reserves

Economic multipliers can be derived from input-output models. These are matrices or tables that describe the interdependencies and flows of money between different sectors within a certain economy. They describe how much a sector (such as the tourism sector) demands from all other economic sectors (e.g., manufacturing, agriculture) regarding intermediate input goods and what shares of these input goods are imported or bought domestically. The input-output tables provide information about the primary input, such as value added, employee compensation, or imports from other regions. Also, the internal (e.g., household and government consumption) and external (e.g., exports) final demand for the produced goods and services is shown (Armstrong/Taylor 2000; Fletcher 1989; Miller/Blair 2009). The advantage of using input-output models for the economic analysis of tourism in biosphere reserves is the availability of a statistically valid and comprehensible approach. This allows for estimating the regional economic effects of tourism in detail and completely.

Theoretically, multipliers vary according to the size and the structure of an economy. Thus, large and diversified economies have higher multiplier effects, while those for smaller and specialized economies are smaller (Wall 1997). However, as mentioned earlier, the value added analysis lacks the ability to differentiate for economic sectors and regions on the indirect impact level. This method instead assumes a general indirect value added ratio of 30%. Moreover, no ratio for estimating induced effects has been derived for German biosphere reserves so far (Chapter 5.2).

These two methodological shortcomings have led to the first input-output analyses for German biosphere reserve and national park cases to work on more precisely quantifying indirect and induced effects of visitor spending. These analyses included the Black Forest Biosphere Reserve and the Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserve (Majewski 2023; 2024; Majewski/Job 2023).

For estimating indirect and induced multiplier effects, regional input-output tables and Type I and Type II output multipliers were used from the IMPLAN input-output model. This U.S. commercial input-output model is also used by the U.S. National Park Service (Koontz et al. 2017). The data for the two biosphere reserve cases refers to the German district level. For the Black Forest Biosphere Reserve, the regional economy is defined as the four administrative districts Freiburg/Breisgau, Breisgau-Hochschwarzwald, Lörrach and Waldshut (Majewski 2023). For the Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserve, one single district Nordfriesland defines the regional economy for the Halligen and Pellworm Island, which represents the biosphere reserve (Majewski/Job 2023).

The Type I value added multipliers for the Black Forest Biosphere Reserve vary between 1.2243 for leisure activities, whose services depend on a high level of output and fewer intermediate inputs, and 1.4022 for local transport, where a larger share of the value added is generated by intermediate inputs. The Type II value added multipliers range from 1.3176 for leisure activities to 1.5595 for hotels and restaurants, where a high input of labor in the form of employee compensation is necessary for the provision of services, which affects the induced consumption effect.

The Type I value added multipliers for the Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserve vary between 1.1745 for spa services and products because of a high level of internal output in this branch and 1.2960 for local transport. The Type II value added

multipliers range from 1.2192 for other services and 1.3535 for local transport.

Within the Black Forest Biosphere Reserve, the tourism multiplier effect generates an indirect value added of € 29.88 million and an induced value added of € 13.03 million. The economic impact of visitors with a high affinity for the biosphere reserve amounts to € 153,700 indirect and € 66,400 induced value added.

Within the Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserve, the tourism multiplier effect generates an indirect value added of € 2.89 million and an induced value added of € 692,000. The economic impact of visitors with a high affinity for the biosphere reserve amounts to € 289,700 indirect and € 70,500 induced value added.

The input-output analysis of the two cases reveals sector and spatial multiplier variations varying significantly from the general indirect value added ratio assumption of 30 % in the value added analysis. The indirect value added ratio amounts to 30.6% for the Black Forest Biosphere Reserve and 19.2 % for the Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserve. The study regions, therefore, exhibit noticeable differences in the multiplier effects across different regional structures. Thus, it becomes evident that the regional economies of the two biosphere reserves are characterized by diversity.

The regional economy for the Schleswig-Holstein Wadden Sea and Halligen Biosphere Reserve is smaller, thus including fewer intermediate transactions within the region, leading to a smaller multiplier effect. In contrast, the regional economy within the Black Forest Biosphere Reserve is larger and more interconnected, resulting in higher multiplier effects of visitor spending. Hence, the input-output analysis provides an empirical means to systematically examine the multiplier effects of tourism within biosphere reserves in a statistically comprehensible manner. This method is transparent and reliable, which is why it is acknowledged as the international standard procedure by several protected area institutions (Spenceley et al. 2021).

6 Policy implications

6.1 Case studies and long-term monitoring

Single studies of visitor numbers to biosphere reserves and other protected areas and their economic impacts can provide useful information. They can be used to get in-depth information and detailed studies of visitors for one or more locations at a particular time.

Far more than that, long-term monitoring efforts repeat the use of the same survey and analysis over time to identify and measure changes and trends in visitation and visitor spending. The information gathered on the changes can be used to evaluate protected area management strategies and improve park visitor management. This strategy may help park authorities to improve the quality of visitor experience, reduce the adverse effects of tourism on sensitive habitats, and enhance their beneficial impacts on local communities. A good long-term monitoring is based on two key factors: (1) continuous visitor counting and periodic repetition of visitor surveys and (2) a consistent methodology. Furthermore, effective monitoring programs need good design, careful selection of indicators and measurements, and a long-term commitment to financing the human resources, equipment and infrastructure required (Miller/Twining-Ward 2005).

6.2 Requirements for a long-term economic monitoring program

The first and most basic requirement is a standardized definition of key terms. A consistent and precise use of terms such as visit, visitor and visitor day is essential for a transparent methodology and comprehensive results in the long run (see the glossary of key terms in Chapter 2).

The second requirement is a clear and harmonized methodology that meets certain quality standards, which can be repeated using a standard procedure over time. These standards ensure the necessary quality for reliable outcomes, as well as allow for comparisons to other studies on a national and international level and over time. These standards can include consistent visitor segmentation and spending categories, as well as using the same counting and sampling technique and questionnaires. The questions must cover all the information necessary to calculate economic effects, including questions about the visitation (e.g., length of stay, number of entries, group size) and spending patterns as well as demographic information such as age, gender, place of primary residence, region, and country of origin. Indeed, the park affinity issue needs to be covered, too.

Consistency is the key

Before implementing a long-term monitoring program, a great deal of thought should go into the initial survey design, interview locations, time intervals and choosing the preferred counting methodology. Academic research needs to be innovative to be published in ranked journals, and therefore, researchers may look for methodological alterations or improvements. By contrast, biosphere reserve and protected area managers aim to keep replications as consistent as possible to receive comparable information and track trends in visitation and visitor spending over time. However, the need for consistency leads to a lack of flexibility, meaning that once selected and used, any modifications to the core elements should be avoided. Therefore, extensive field testing and pilot studies at different sites are crucial before implementation to improve and finalize the approach and tools.

Even carefully planned long-term visitor monitoring may require some changes to the core methodology at some point in time. For example, funding cuts may force to reduce the survey number or counting samples; innovative new cost-effective visitor counting methods may substitute old methods; changes in visitation and spending patterns may require different counting locations or visitor segmentation; and site-specific knowledge may build up over time that allows to improve the program by changing the sampling strategy (e.g., counting locations and times, visitor segmentation, accounting for new attractions). Such changes in the methodology may often involve a trade-off between consistency and improving the visitor monitoring program. If changes are necessary, their expected impact on the results and consistency should be carefully considered and reported.

Another issue is the necessary human resources needed to monitor regularly over multiple decades. For example, additional support may be required if visitor counting is not done automatically (e.g., using automated counters) or if interviews are conducted face-to-face. Suitable options could include using trained students from local universities (especially from thematically related degree programs), biosphere reserve staff, and volunteers – using the idea of citizen science. Citizen science can have the added benefit of developing strong partnerships and engagement with communities, particularly when there is appropriate training and oversight (Leung et al. 2018). Alternatively, a park authority may decide to outsource the monitoring to an external consultancy so that they do not need to provide internal training to staff or manage numerous volunteers. Completed surveys (and/or the digitized data) need to be checked regularly – even with well-trained and experienced interviewers – as this can identify and eliminate problems or misunderstandings and help maintain the quality of the overall samples over the years.

Frequencies of Data Collection

When deciding on the time intervals between replications of data collection, it is important to note that different frequencies can be applied to different data. Visitor numbers, for example, can differ vastly from year to year because of changing weather conditions, new infrastructure, or singular events (e.g., anniversary celebrations, natural hazards, health crises), and are prone to influencing factors such as socioeconomic or political stability. Therefore, data on biosphere reserve visitor numbers should be collected more regularly (e.g., continuously or annually). Surveys on visitor spending are typically a more complex and costly aspect of visitor monitoring. Therefore, survey data may be collected only every five years. Whichever frequency is chosen, biosphere reserve managements should at least compile annual reports of visitor numbers and use these to make new calculations for that year's economic effects.

However, depending on the budget available, data collection may only permit surveys at greater time intervals. Basically, the UNESCO biosphere reserve status is evaluated every ten years. Hence, for German biosphere reserves, the intention is to include an input-output analysis research on nature-based tourism as standard procedure ahead of each reporting period to be able to integrate the gained results in all future evaluation reports for UNESCO's MAB bodies (see Chapter 6.3).

External and Internal Reporting

The issue of consistency is also valid for reporting. Over time, preferences for the types of information reported may change depending on the biosphere reserve's authority's policy priorities. However, to allow for comparisons over time and for general understanding, every publication should contain the same set of standard reporting variables. Of course, biosphere reserve and other park managers are free to convert these variables to match changing reporting needs. However, these conversions should always be in addition to the original variables. For further transparency reasons, the date of each data set used should be clear each time.

Detailed documentation relating to each survey or visitor counting exercise is essential to build institutional memory. This is highly important to ensure a consistent implementation of the monitoring methodology and so that it is not affected by any changes in management personnel. This documentation should include manuals, research protocols, location coordinates, photographs of all survey and counting sites, the analysis tool used to compute the visitor spending effects, and reporting guidance. For optimal transparency, it is advised to keep year-on-year records, either digitally or as hard copies and share them internally (Schägner et al. 2017).

For quality assurance, it is recommended that there should always be at least two staff members in a park authority who understand the methodology and tools. They can then oversee the visitor counting procedures, survey execution and evaluation and pass on that knowledge to their successors.

6.3 Implications for Germany's UNESCO biosphere reserves

The first surveys on the economic impact of tourism in Germany's biosphere reserves began in 2010 with the two Biosphere Reserves Rhön and Thuringian Forest. Since then, not only the perimeters of the Rhön and the Thuringian Forest, but also those of other biosphere reserves have been expanded. Changes in local conditions have happened; for example, newly established information centres or new offers for certain target groups cannot generally be considered in projections or forecasts, which is why the continuous and systematic collection of tourism structure data is absolutely necessary. Therefore, we argue for implementing a permanent regional economic monitoring of German biosphere reserves according to a uniform standard.

This report presents singularly collected data for all German biosphere reserves. The surveys were carried out in scientific research projects, and the respective implementation with project applications, on-site surveys, data analyses, and presentation and reporting of results took a long time. Meanwhile, there has been no further update of visitation data, but the figures presented in this report refer to the time of the primary surveys and – as already mentioned – to the respective area perimeters at that time. This situation calls for an urgent as well as continuous update of the visitor numbers to German biosphere reserves. The visitor structure is the critical variable for determining the total number of visitor days in our large-scale biosphere reserves. Changing visitation structures, including their expenditure, can only be recorded on-site, which is why a periodic analysis of the nature-based tourism demand structure in the biosphere reserve destinations is absolutely necessary every ten years, corresponding to the duration of a UNESCO evaluation period for biosphere reserves, including reporting to the International Coordinating Council (ICC) in Paris.

The overnight stay figures of the official statistics serve as the basis for data extrapolation (see Chapter 3.5). These can be called up monthly for the municipalities of the biosphere reserve regions, which has the advantage that the number of visitor days can be updated, e.g., annually, as 'desk research', using this official statistical basis. Together with a periodic update of the number of day visitors and overnight guests, which should be carried out at least every five years, a solid visitor monitoring can be established. Automatic counters can be installed as a backup to record visitor movements over the year or day. It should be noted that automatic counts can only give small-scale insights into the number of visitors at specific sites. General visitor days or visit structures can be derived from this data only by experts with a sound knowledge of the region and long methodological experience in the field of research.

Available financial, time or personnel resources, as well as external and unforeseeable influences, such as the recent Covid 19 pandemic, can have a negative impact on the sample size. Regarding the data situation, the day types (defined according to season, day of the week and weather conditions; Chapter 3.5) are not sufficiently covered. However, the weather is the most critical variable because it cannot be influenced. As a consequence, data gaps must be supplemented by modelling to estimate the visitor structures (Frieser et al. 2023). To avoid such gaps in principle and to achieve a sufficient sample, a minimum number of survey dates should be set. In the highly frequented biosphere reserves at the Wadden Sea or Berchtesgadener Land, an adequate sample size could be realized despite the lower number of surveys days (related to the Covid 19 pandemic). In areas with lower visitor numbers, however, the average survey duration of ideally 18 days should be adhered to, as otherwise the sample may be too small to analyze solid expenditure values differentiated by relevant visitor groups. A data collection with at least twelve survey days must be secured in all biosphere reserves to achieve the coverage of the twelve day types.

A central criterion of the economic impact analysis is the economic stimulus associated with the biosphere reserve. The economic impact refers to a travel motivation because of a biosphere reserve designation in the region. The operationalization of visitors with a high affinity for the biosphere reserves differentiates the core group of visitors for whom the biosphere reserve is the attraction for the visit. For no other nation comparably well-founded findings on such a regionally economically significant core group of visitors to biosphere reserves can be found. This data situation, which is therefore unique in an international comparison, must continue to be updated within a permanent and integrative monitoring (Bach/Larondelle 2023).

Over the past years, the value added analysis was applied for estimating the economic effects of tourism in German biosphere reserves. This method builds on value added ratios to asses direct and indirect economic effects. For the indirect effects level, the method assumes an indirect value added ratio of 30% of the intermediate consumption remaining in the local area as indirect value added, regardless of economic sector or regional variations. Furthermore, no induced effects can be estimated. In studies and monitoring systems of protected area institutions in, for example, the USA, Finland, Canada, Brazil, Namibia, or South Africa, the economic effects of tourism are estimated by conducting input-output analyses as standard. Also, the guidelines explain the use of input-output models to derive regional economic multipliers (Spenceley et al. 2021). The analysis of the two cases, Black Forest and Schlewig-Holstein Wadden Sea and Halligen Biosphere Reserves, revealed spatial multiplier variations. The input-output analysis, moreover, can offer the opportunity to assess the economic impacts of tourism in biosphere reserves on a statistically comprehensible, transparent, and solid basis.

In the long term, the regional economic monitoring of biosphere reserves must develop practicable approaches to apply a reliable calculation method. Furthermore, the international comparability of methodology and data should be striven for, for which Spenceley et al. (2021) have already anchored the analytical framework for science and practice with their guidelines. For the permanent updating of the indicator "value added from tourism", the aim should be to construct an automated regional economic model (comparable to the "Visitor Spending Effects Model" of the National Park Service; Koontz et al. 2017), so that the regional economic effects of tourism in the biosphere reserves can be automatically calculated and communicated on a continuous basis and appropriate management measures can be derived.

The functional nature of biosphere reserves, with their explicit research and monitoring mandate, makes it urgently necessary to transfer previous achievements in the field of regional economic evaluation into continuous monitoring. The UNESCO World Network and its frequently practiced global Twin Partnerships also make it necessary to become internationally connectable. A permanent implementation of a monitoring system for the biosphere reserves within the framework of the reporting obligations of the MAB program is essential. Regular surveys could be systematically linked to the periodic review of biosphere reserves by the MAB National Committee (German National Committee for the UNESCO MAB Programme 2007). An update of the figures every ten years would be perfectly adequate and, in view of the different reporting frequencies, would in no way lead to an unwanted accumulation of surveys within one year.

Biosphere reserves are an innovative and extremely ambitious conglomerate of very different spatial and, thus also, tourism structures, which means that the procedure for calculating tourism value added and employment effects can be designed differently in their analysis. For this very reason, central coordination of any primary data collection is crucial and a uniform and standardized procedure is urgently needed – only this allows reliable nationwide data comparison and area-specific benchmarking. The umbrella organization of the National Natural Landscapes e.V. is logistically well suited for the central management of ongoing survey activities and the collection of data on visitor numbers and regional economic effects. The implementation can be carried out by local partners, such as colleges or universities, to minimize the logistical effort and to utilize endogenous knowledge resources in a participatory manner (Brenner/Job 2022).

7 Lessons learned for EuroMAB and the World Network of Biosphere Reserves (WNBR)

The Eberswalde Declaration on Research in, for and with UNESCO biosphere reserves (2022), endorsed by the International Coordinating Council of the UNESCO MAB Programme at its 34th Session in 2022, included a set of recommendations on how to deal with research on BRs in the future (UNESCO 2022). Socio-economic research, as well as research on ecosystem services and their monetary benefits, is clearly extremely relevant for the World Network of Biosphere Reserves (WNBR) as they link biodiversity conservation, sustainable use and benefits for people.

During EUROMAB 2022 in the Biosphere Reserve Nockberge/Austria, some of the first results of research on the regional economic effects of tourism in the German biosphere reserves were presented for the first time to the EuroMAB community. The discussion revealed that the methodological approach followed is of great interest to European biosphere reserves as it is innovative and provides valuable results for management as well as the communication of biosphere reserves.

Building on the research and the results presented (Chapters 3, 4 and 5) and the lack of similar studies for European biosphere reserves, it can be noted that research in, with and for biosphere reserves urgently needs to cover socio-economic topics as much of the current research still focuses on ecological themes. Sustainable tourism and its contribution to the regional economy – as it is relevant for almost all UNESCO biosphere reserves – is a key topic.

Research in this regard needs to be embedded in the research program/concept of each BR. The applied research in Germany has clearly revealed the need for regular assessments and inclusion in biosphere reserve monitoring programmes. We assume this is also the case for biosphere reserves in the EuroMAB network.

As we argue for implementing a permanent regional economic monitoring of German biosphere reserves according to a uniform standard, this could and should also be transferred to the European level. Standardized monitoring of the regional economic effects of tourism in biosphere reserve could serve as an important benchmark for biosphere reserves in the EuroMAB network as well.

Beyond Germany, an evaluation of the regional economic effects of tourism can be found, for example, for the biosphere reserves Entlebuch and Engiadina Val Müstair in Switzerland (Backhaus et al. 2013; Knaus 2012). The indirect and induced value added were calculated using multipliers from another study (Rütter et al. 1996). When it comes to the methodology for conducting regional economic impact analyses, it is imperative to harmonize practices in both Switzerland and Germany. This harmonization is essential to facilitate the long-term adoption of internationally recognized standards, particularly input-output analysis, within both countries. It is crucial to highlight that in both Switzerland and Germany, the assessment of the economic impact of the biosphere reserve is meticulously carried out. This includes a comprehensive evaluation of the biosphere reserve's influence on visitors' travel decisions. The emphasis on assessment should be upheld through ongoing monitoring to closely track how the perception of biosphere reserves evolves within the EuroMAB network.

Application of the standardized approach for evaluating regional economic effects of tourism in biosphere reserves in the EuroMAB network could serve as a test case for the World Network of Biosphere Reserves.

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A Example counting sheet for the Swabian Alb Biosphere Reserve

CHAIR OF GEOGRAPHY AND REGIONAL SCIENCE
JULIUS-MAXIMILIANS-UNIVERSITÄT WÜRZBURG

Count Sheet Swabian Alb

Interviewer: ________________________ Date: __________ Location: ______________________________

Time of count/flash interview start: ____________ **Time of count/flash interview end:** ____________ **(use a new sheet for each counting interval!)**

Frequency	Quantity		Number of nights/category/postcode (Please record day visitors with "0" nights!)
Walker 1 2 3 4 5 10			
Hiker 1 2 3 4 5			
Cyclist/MTB 1 2 3 4 5 10			
Motorcyclist 1 2 3 4 5 10			
Swimmer 1 2 3 4 5 10			
Watersports 1 2 3 4 5 10			

B Example survey for the Swabian Alb Biosphere Reserve

INSTITUTE OF GEOGRAPHY AND GEOLOGY
JULIUS-MAXIMILIANS-UNIVERSITÄT WÜRZBURG

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Dear guests,
we're students from the University of Würzburg. For a research project we're conducting a survey on the economic effects of tourism in the area of the Swabian Alb. Would you be so kind to answer some questions on your visit? This information will be very important for us and it will only take 10 minutes. All of your answers will be absolutely confidential.

Nr.: ..... **Date:** ..... **Time:** .....

Interviewer: ..... **Location:** ..... **Rejection:** .....

Weather: □[1] cloudless □[2] fair □[3] cloudy □[4] overcast □[5] rain

Activity: □[1] walker □[2] hiker □[3] cyclist □[5] motorcyclist □[6] swimmer □[7] nature watcher □[8] water sports

Remarks: .....

1) Where did you sleep last night?
□[1] hometown or □[2] holiday resort: .....

1a) Where will you stay tonight? (*day-tripper continue with question 2*)
□[1] hometown or □[2] holiday resort: .....

1b) How long did you already stay here?
..... nights

1c) Total number of overnight stays during the entire trip:
..... nights

1d) Please describe the type of your accomodation:
□[1] *hotel (garni)* □[1] *up to 30€* □[2] *up to 50€* □[3] *up to 75€* □[4] *over 75€* *per person/night*
□[2] inn □[5] health clinic □[8] friends/relatives
□[3] guesthouse □[6] youth hostel □[9] other: ……
□[4] vacation apartment □[7] camping □[99] not specified

1e) Are meals included in the price of your accommodation?
□[1] no meals □[2] breakfast □[3] half board □[4] full board □[99] not specified

1f) Is your trip to this region...
□[1] a package tour □[2] a self-organized trip *(continue with question 2)* □[3] cure *(continue with question 2)*

1f)i) For package tours:
total price: ..... €
for ..... persons

1f)ii) Services included in the package?
.....
.....

2) Please name the two most important reasons your visit today:
i)..... ii).....

3) Do you know the state of protection of this region? Is it a... *(rotation of items, multiple answer possible)*
□[1] nature reserve □[2] protected landscape □[3] biosphere reserve
□[4] nature park □[5] national park □[6] I don't know

4a) Why are you in the region now?
□[1] vacation/leisure time □[2] business □[3] cure □[4] other: .....

4b) What are your main activities in this region?
....
.....

5) By which means of transport did you come here today?
□[1] car □[2] railway □[3] coach □[4] bike □[5] motorbike □[6] other: .....

6) Do you know the label „National Natural Landscapes"?
□[1] yes If yes, please give two examples of „National Natural Landscapes": i).....
□[2] no ii).....

7a) Are you aware that there is a biosphere reserve in this area?
□[1] yes □[2] no *(continue with question 8)*

7b) In your decision to visit the Swabian Alb area, how important was the fact that this is a biosphere reserve?
□[1] very important □[2] important □[3] not important □[4] no importance at all

7c) Would you be here today if the biosphere reserve did not exist?
□[1] yes □[2] no □[3] maybe

(For overnight guests)
8) Is this your first visit to this region?
□[1] yes □[2] no, 2nd-5th time □[3] no, 6th-5th time □[4] no, 11 times or more

9) Please name two top attractions of this region! Which did you visit / intend to visit?
..... □[1] .....
□[1]

10) In which areas would you wish further offers in the biosphere reserve *(multiple answer possible)*

□[1] multi-day hikes
□[2] one-day hikes / trails
□[3] suggestions for fay trips by bicycle
□[4] theme routes for bicycles
□[5] regional gastronomy
□[6] shops for regional products
□[7] recommendations for sites of specific plants
□[8] recommendations for oberservations points of animals
□[9] other: ……

11) What are your expectations when you visit a UNESCO Biosphere Reserve? *(multiple answer possible)*

□[1] special nature experience
□[2] interesting cultural landscape
□[3] sustainable tourism offers
□[4] good public transport network
□[5] wide range of regional products
□[6] variety of cultural offers
□[7] good information centers
□[8] offers of health care

12) How much did you spend (or will you spend) for you and your fellow travelers during the trip?

	D.K.	N.F.S.	Ø Average expenses per day per person **(0 = Nothing)**	sum	num. of days	num. of pers.
a) accommodation *(not for day-trippers)*	□[-9]	□[-99]	€ .....**per night**			
b) meals/beverages (restaurants)	□[-9]	□[-99]	€			
c)i) groceries	□[-9]	□[-99]	€			
c)iii) sum of purchases for items under 50 € (other)	□[-9]	□[-99]	€			
c)iv) singles purchases over 50 € (separately)	□[-9]	□[-99]	€ ..... € ..... €			
d) sports/leisure/entertainment/culture (incl. admissions)	□[-9]	□[-99]	€			
e) transportation use during the stay - public transport (regular busses, trains) , taxi etc. - excursions bus/boat, cable railway, gondola, ski lift etc. - parking fees	□[-9]	□[-99]	€ ..... € ..... €			
f) visitor's tax/guest card	□[-9]	□[-99]	€			
g) cure (baths/massages etc.)/medical expenses	□[-9]	□[-99]	€			
h) congress/conference/seminar fees etc.	□[-9]	□[-99]	€			
i) biosphere reserve specific services	□[-9]	□[-99]	€			
j) other services	□[-9]	□[-99]	€			

One of the goals of biosphere reserves is to strengthen regional value creation.

13a) Did you buy regionally produced food during your stay?
□[1] yes □[2] no *(continue with question 14)*

13b) How much have you spent on regionally produced food?
Total price: ..... €

14a) Did you buy other regionally produced goods during your stay?
□[1] yes □[2] no *(continue with question 15)*

14b) How much have you spent on regionally produced goods?
i) ..... €
ii) ..... €
iii) ..... €

Finally, we ask you for a few details for the statistics:

15) Where do you live (main residence): Postcode: ..... Country: .....

16a) Please specify your age and the age of your fellow travelers!
..... □[1]f □[2]m ..... □[1]f □[2]m ..... □[1]f □[2]m
..... □[1]f □[2]m ..... □[1]f □[2]m ..... □[1]f □[2]m

16b) How big is your travel group in total?
i) number of persons: .....
ii) of which children: .....

17a) What is your education level?
□[1] still in school □[2] no graduation □[3] secondary school qualification □[4] secondary school □[5] A-levels □[99] not specified

17b) Do you have a university degree?
□[1] yes □[2] no □[99] not specified

17c) Which occupation group do you belong to?
□[1] self-employed □[2] senior official/manager □[3] blue-collar worker/craftsman □[4] homemaker
□[5] retiree □[6] employee/public official □[7] student/trainee/apprentice □[8] not employed

17d) Finally, may I ask you for your household income (net)?
□[1] < 2000 € □[2] 2000 bis < 3000 € □[3] 3000 bis < 4000 € □[4] 4000 bis < 5000 € □[5] > 5000 € □[99] k. A.

Thank you for your cooperation!

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