

# ENVIRONMENTAL VALUATION USING CHOICE EXPERIMENTS

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# OVERVIEW

1. Why economic valuation?
2. An example - preferences for forest biodiversity
3. 10 steps toward a hypothetical market
4. Designing choice experiments
5. Estimating models





# WHY ECONOMIC VALUATION?



# ECONOMIC FOUNDATIONS

- Whether something contributes to human wellbeing is from an economic point of view determined by individuals  
=> **individual's preferences count**
- The context of interest to reveal these preferences is the **market**
- People express preferences through their **willingness to pay** (buy something) or their **willingness to accept** (sell something)





# ECONOMIC FOUNDATIONS II

- Many **environmental goods and services** contribute positively to human wellbeing, accordingly they do have economic value
- However, environmental goods are **often not properly allocated by markets** because of their public goods characteristics  
=> **non-marketed goods and services**
- **Public goods** are characterized by non-excludability and non-depletability



# PUBLIC OR PRIVATE GOOD?

|                      | Public | Private |
|----------------------|--------|---------|
| Endangered species   |        |         |
| Urban park           |        |         |
| Timber from forests  |        |         |
| Attractive landscape |        |         |
| Flood control        |        |         |



# ECONOMIC FOUNDATIONS

- Markets are not good in providing public goods, it is likely that they are **not sufficiently supplied as** demand is likely to be higher than supply if good is valuable
- Accordingly, there is a **need for information** on the values of these services and goods
- **Economic valuation** is a way forward to collect the information regarding the demand for (environmental) public goods



# ECONOMIC FOUNDATIONS

- Economic valuation is concerned with marginal values, i.e., we are interested in the **value of a change** in the quantity and / or quality of an environmental good or service (How many additional hectares of natural forest do you prefer? One, two, three ... units?)
- Economic valuation is not valuing stocks!  
~~What is the value of all polar bears living at the moment on earth?~~  
This is not a question we do ask – economic valuation **is about valuing changes!!!**



# TOTAL ECONOMIC VALUE

- Total Economic Value (TEV) is a common concept used in many valuation studies
- Basic assumption is that economic value people derive from environmental services is **not only associated with direct use**
- Also the **knowledge that something exists**, for instance a certain species, can be of value for people



# TEV OF AQUATIC ECOSYSTEM

| Direct value                        | Indirect Value          | Nonuse Value                                |
|-------------------------------------|-------------------------|---------------------------------------------|
| Outputs directly consumable         | Functional benefits     | Value from knowledge of continued existence |
| Commercial and recreational fishing | Nutrient retention      | Habitats                                    |
| Transportation                      | Flood control           | Species                                     |
| Wild resources                      | Storm protection        |                                             |
| Potable water                       | Habitat function        |                                             |
| Recreation                          | Shoreline stabilization |                                             |



# SUITABLE VALUATION METHODS

| Method                                                                  | Value        | Application                         |
|-------------------------------------------------------------------------|--------------|-------------------------------------|
| Travel Cost                                                             | Use          | National Parks                      |
| Hedonic pricing                                                         | Use          | Residential Property                |
| Production function                                                     | Use          | Commercial and recreational fishing |
| <b>Stated Preferences</b><br>contingent valuation<br>choice experiments | Use & Nonuse | For (nearly) everything<br>😊 ☹️     |







# **AN EXAMPLE — VALUING BIODIVERSITY CHANGES**

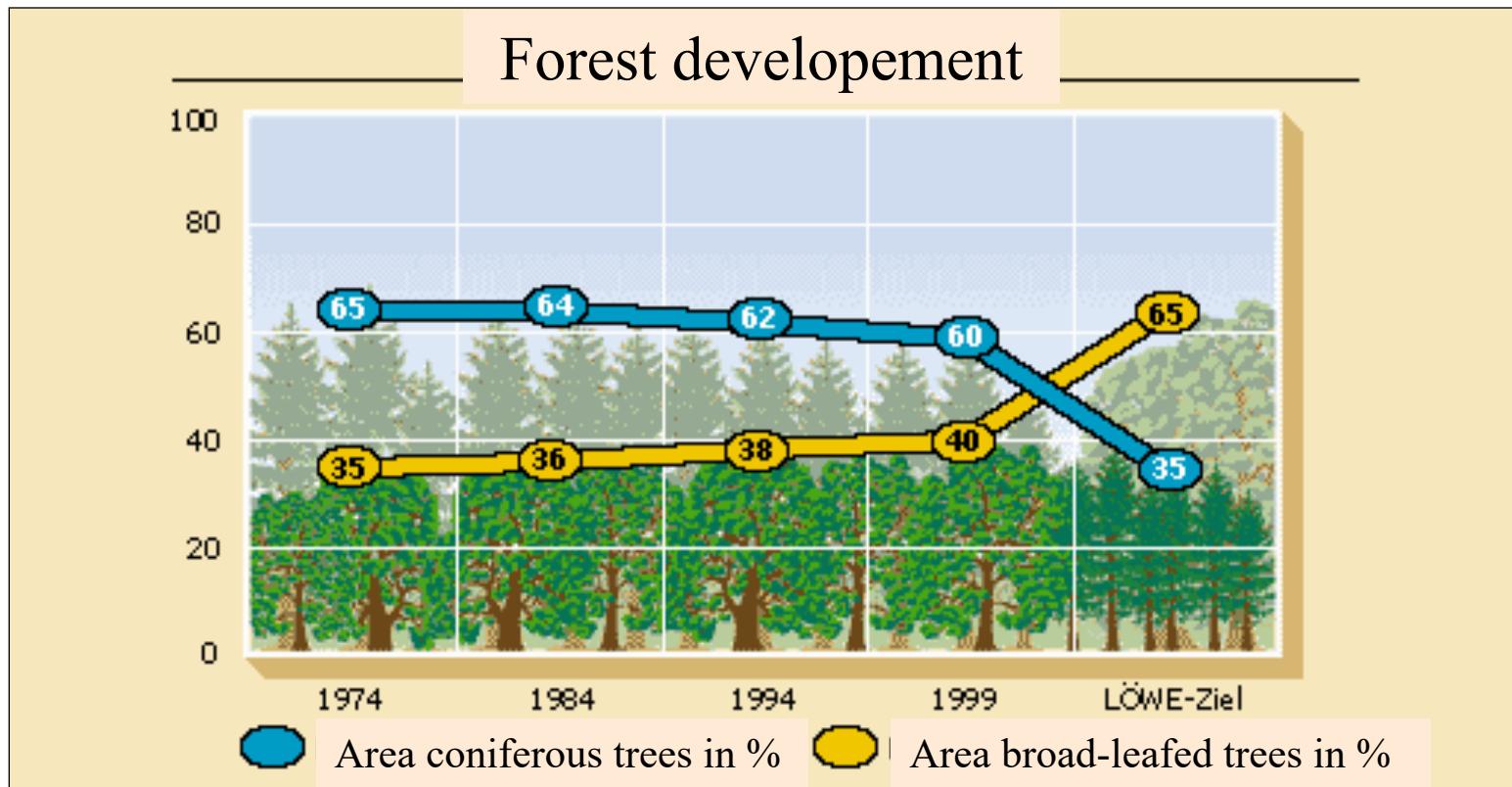


# OBJECTIVES OF THE PROJECT

1. Assessment of the **effects** of forest development strategies **on biodiversity**
2. Measuring the **economic benefits** of different levels of forest biodiversity using **stated preference methods**
3. **Cost-benefit analysis** for forest development strategies



# FOREST CONVERSION

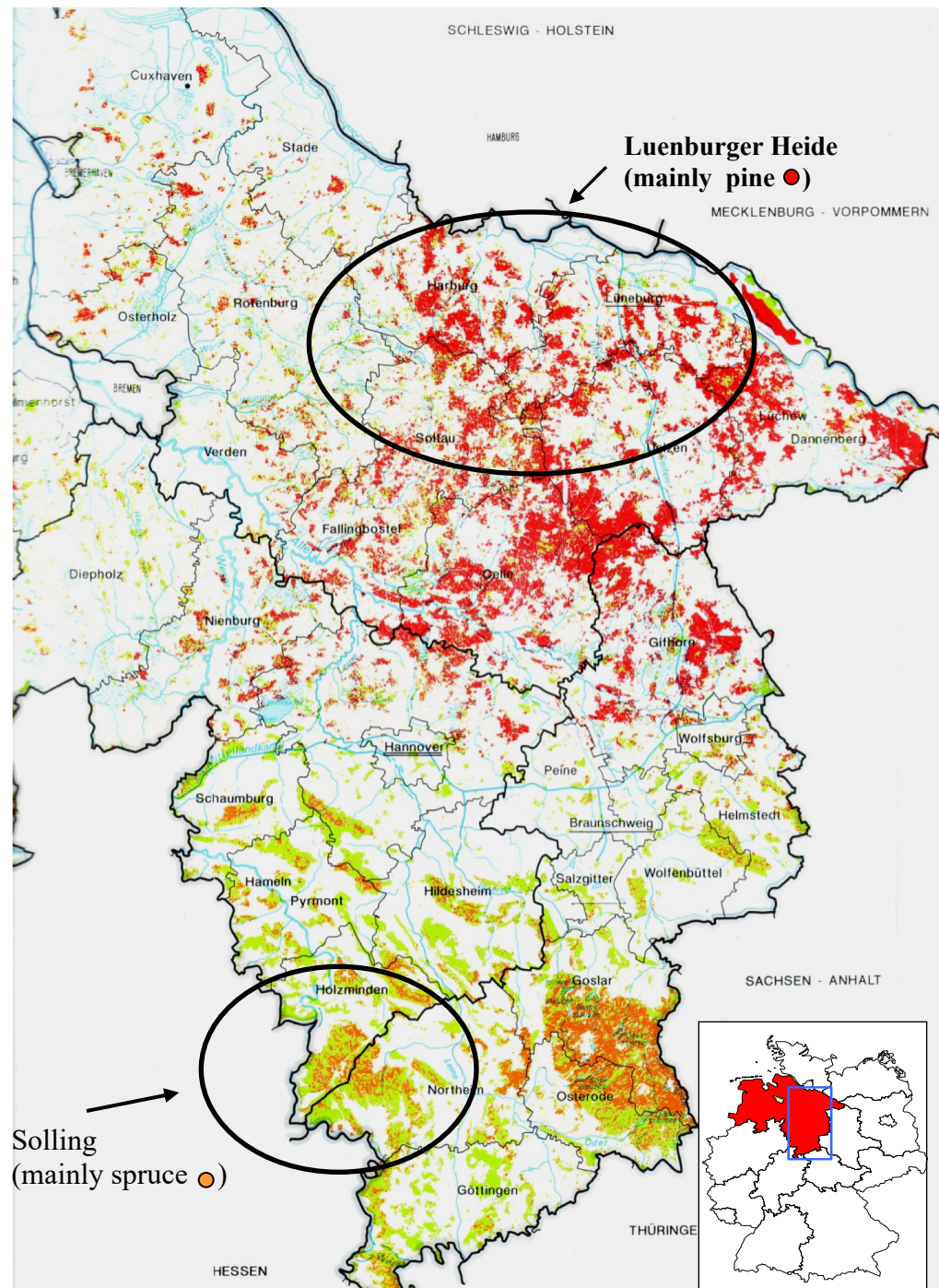


# FOREST DEVELOPMENT STRATEGIES

- **LOEWE** (Long-lasting Ecological Forest Development), forest development program of Lower Saxony
- **Protection of ecological processes:** priority on the integration of ecological processes into the silvicultural management
- **Maximum net yield:** priority on a high percentage of coniferous trees and non-indigenous trees, respectively
- **Potential natural vegetation:** hypothetically constructed natural forest vegetation
- **Natural woodland:** no further silvicultural management and timber use



# POTENTIAL AREAS FOR FOREST CONVERSION







# **SURVEY DEVELOPMENT**



# 1. STEP: FOCUS GROUPS

## Objectives

- people's perception of forests in their region
- knowledge about (forest) biodiversity
- selection of attributes for CE
- acceptance of economic valuation

## Implementation

- Inviting people from study region
- Survey company called randomly selected people
- 3 focus groups in each study region
- People were invited for 2 hours in the evening to come to town halls and discuss with us



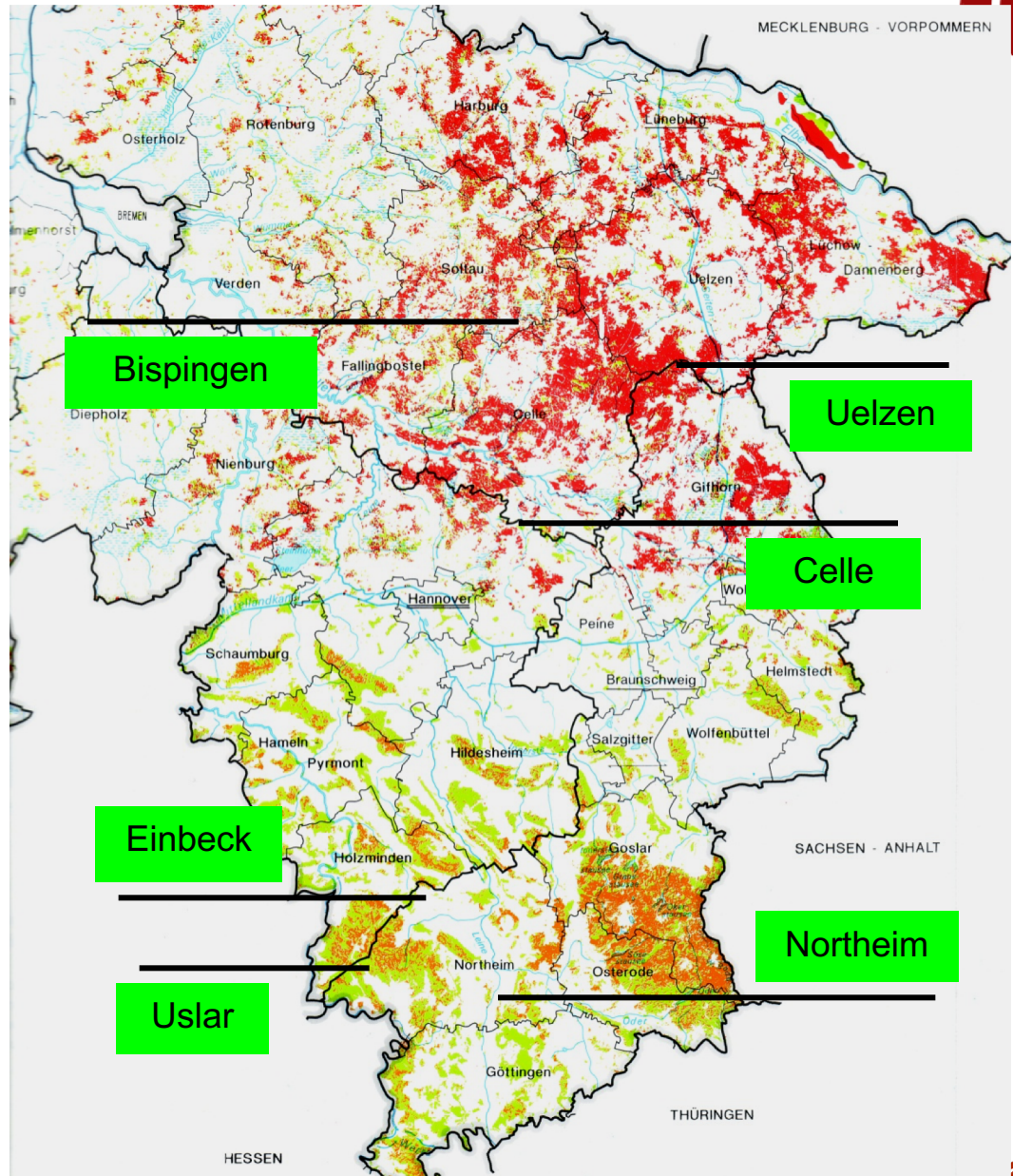
# FOCUS-GROUPS IN ...

N = 46

40% female

Age Ø 50  
(from 19 to 80)

Income Ø € 2,075



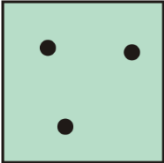
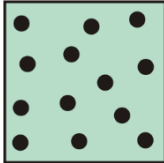
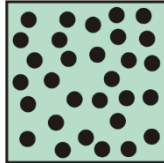
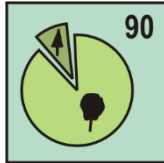
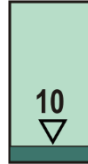


# MAJOR RESULTS FOCUS GROUPS

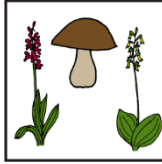
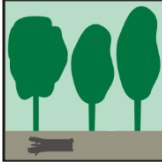
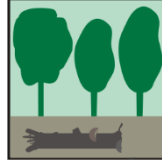
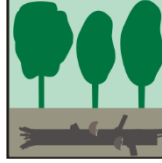
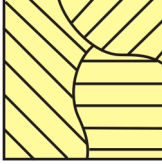
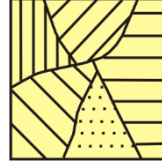
- Participants were mainly **familiar with topics, i.e.** ratio of coniferous/broad-leaved trees, forest age class or dead wood.
- Asked what they associate with **biodiversity** or how they would describe it, most people solely mentioned the **number of species**.
- **No protest** against monetary valuation of biodiversity due to ethical considerations, for example.
- **Payment vehicle** - contribution to a fund „Forest conversion - and **administration** of that fund by the Lower Saxony Forest Planning Agency was **accepted/plausible**.



# ATTRIBUTES FOREST BIODIVERSITY

| Attribute                         | Symbols for attribute levels                                                        |                                                                                       |                                                                                       |
|-----------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                   | low                                                                                 | medium                                                                                | high                                                                                  |
| Number of species                 |    |    |    |
| Percentage of broad-leaved forest |    |    |    |
| Forest age class                  |  |  |  |
| Percentage of non-native species  |  |  |  |



| Attribute                                               | Symbols for attribute levels                                                        |                                                                                       |                                                                                       |
|---------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                                         | low                                                                                 | medium                                                                                | high                                                                                  |
| Number of endangered and protected species and habitats |    |    |    |
| Percentage of dead wood                                 |    |    |    |
| Landscape diversity                                     |    |    |    |
| Duration of forest conversion                           |  |  |  |

# RANKING OF ATTRIBUTES

| N = 41                                                  | Total | N  |
|---------------------------------------------------------|-------|----|
| Landscape diversity                                     | 56    | 26 |
| Number of endangered and protected species and habitats | 55    | 29 |
| Forest age class                                        | 41    | 18 |
| Number of animal and plant species                      | 33    | 18 |
| Percentage of broadleaved forests                       | 30    | 18 |
| Percentage dead wood                                    | 13    | 5  |
| Duration of forest conversion                           | 9     | 6  |
| Percentage of non-endemic species                       | 9     | 3  |

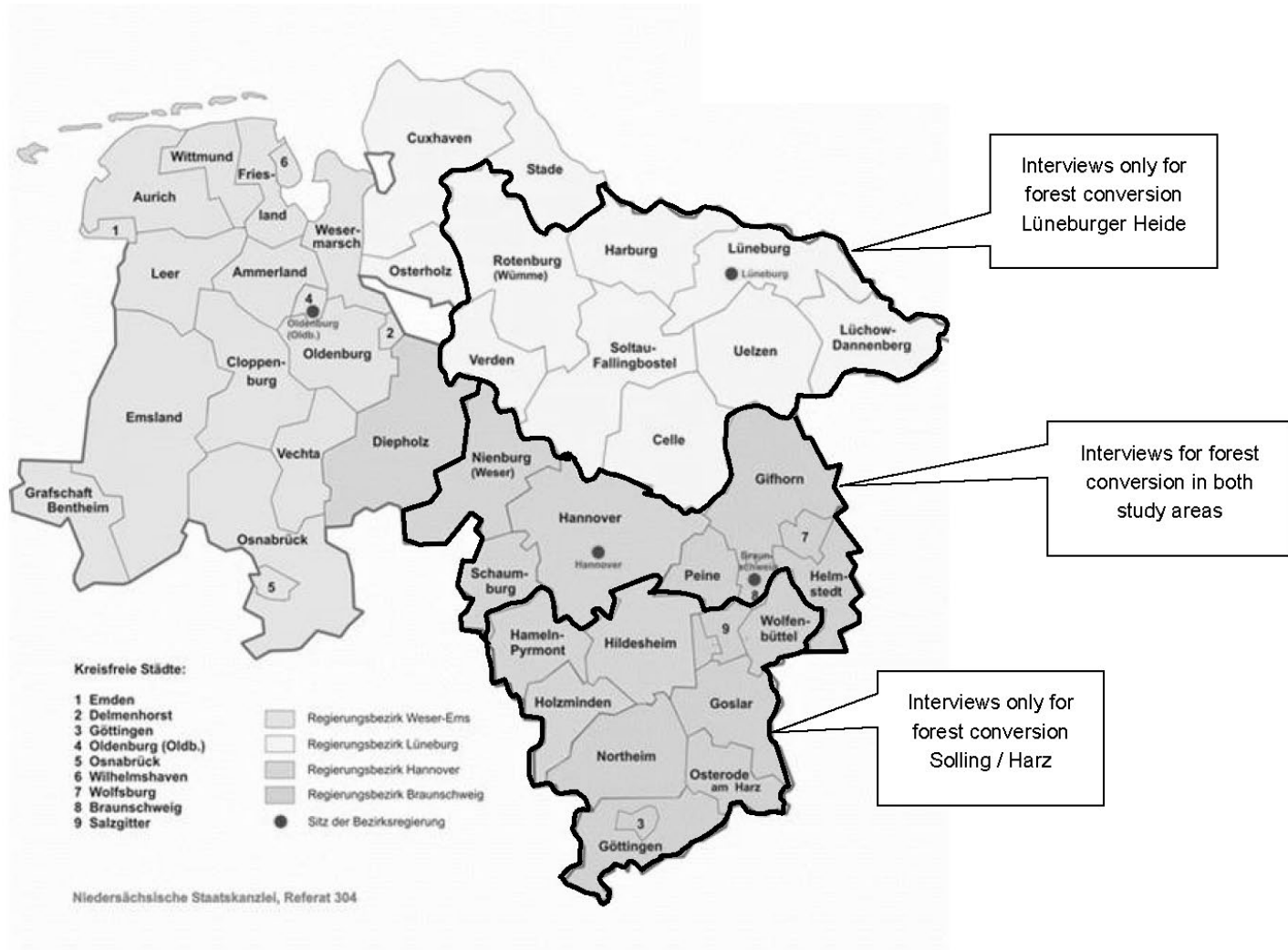


## 2. STEP: SURVEY DESIGN

- **Market size** People living in the study regions
- **Sample** Random sample of inhabitants of forest conversion regions in Lower Saxony (622 interviews)
- **Interview** Face to face by market research firm, 30 minutes on average
- **Information** A map about the conversion area and a information board explaining possible changes in forest biodiversity
- **Eliciting WTP** Each respondent was presented six choice sets



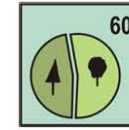
# SIZE OF THE MARKET



# INFORMATION BOARD CHANGES FOREST BIODIVERSITY

## Anteil an Laubwald

Heute hat der Laubwald in der Lüneburger Heide einen Anteil von 30 Prozent. Ein Ziel des Waldumbaus ist es, den Anteil an Laubwald zu erhöhen (vor allem Buchen und Eichen). Für die Lüneburger Heide wird standortgerecht ein Anteil von 60 Prozent angestrebt.



60%

## Biotope für gefährdete und geschützte Arten

Biotope im Wald sind ein wichtiger Lebensraum für gefährdete Pflanzen- und Tierarten. Beispiele sind Alt- und Totholz, kleine Waldquellen und Wälder mit seltenen Baumarten. Die Anzahl dieser Biotope ist niedrig bei einer am Holzertrag orientierten Bewirtschaftung. Umgekehrt ist sie hoch bei einer am Naturschutz orientierten Bewirtschaftung. Je mehr Punkte am unteren Rand des Symbols zu sehen sind, desto mehr dieser Biotope gibt es.



niedrig



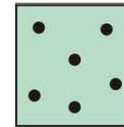
mittel



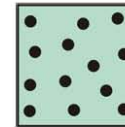
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## Artenvielfalt

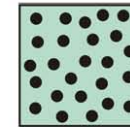
Die Anzahl der Tier- und Pflanzenarten im Wald wird pro Flächeneinheit bestimmt. Sie ist in verschiedenen Laubwäldern (z.B. in Buchen- oder Eichenwäldern) unterschiedlich hoch. Je mehr Punkte in dem Symbol zu sehen sind, desto mehr Tier- und Pflanzenarten gibt es (z.B. Vögel, Insekten, Farne und Blütenpflanzen).



niedrig



mittel



hoch

## Altersstruktur der Wälder

Die Altersstruktur der Wälder kann sehr unterschiedlich sein. Im typischen "Altersklassenwald" gibt es nur eine Schicht an Bäumen, die alle ein gleiches Alter aufweisen (Altersstruktur "niedrig"). Im naturnahen Wald verläuft die Verjüngung der Gehölze weitgehend ohne Zutun des Menschen. Mit verschiedenen Baumschichten weist dieser Wald eine höhere Vegetations-schichtung auf (Altersstruktur "hoch").



niedrig



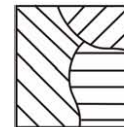
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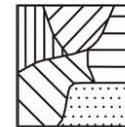
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## Landschaftliche Vielfalt

In der Lüneburger Heide treten verschiedene Typen von Wäldern auf. Hierzu gehören Buchen-, Eichen- oder Kiefernwälder. Es gibt auch Mischwälder, in denen verschiedene Baumarten vorzufinden sind. Eine Veränderung der landschaftlichen Vielfalt ergibt sich, wenn großflächige reine Kiefernwälder (niedrige Vielfalt) in ein kleinteiliges Mosaik aus Buchen-, Kiefern- und Eichenwäldern überführt werden (hohe Vielfalt). Die Flächen in den Symbolen stellen unterschiedliche Waldtypen dar.



niedrig



mittel



hoch

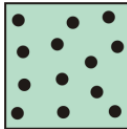


# ATTRIBUTES AND ATTRIBUTE LEVELS

| Attribute                                          | LH                        | SH                        |
|----------------------------------------------------|---------------------------|---------------------------|
| Habitat for endangered and protected species (HAB) | <u>medium</u> , high      | <u>low</u> , medium, high |
| Species diversity (SPD)                            | <u>medium</u> , high      | <u>medium</u> , high      |
| Forest stand structure (FSS)                       | <u>low</u> , medium, high | <u>low</u> , medium, high |
| Landscape diversity (LCD)                          | <u>low</u> , medium, high | <u>low</u> , medium, high |
| Contribution to fund Forest conversion             | 5, 10, 20, 35, 50, 75     | 5, 10, 20, 35, 50, 75     |

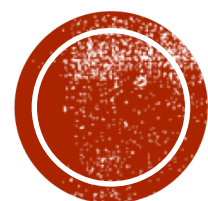


# Example of a Choice Card (SH)

|                                              | without forest conversion                                                                | Program A                                                                                  | Program B                                                                                  |
|----------------------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
|                                              | 40 % broad-leaved                                                                        | 70 % broad-leaved                                                                          | 70 % broad-leaved                                                                          |
| Habitat for endangered and protected species | low     | high    | low     |
| Species diversity                            | medium  | medium  | medium  |
| Forest age class                             | low     | high    | low     |
| Landscape diversity                          | low     | high    | high    |
| Contribution to fund "forest conversion"     | 0      | 35     | 20     |
| I choose <input checked="" type="checkbox"/> | <input type="checkbox"/>                                                                 | <input type="checkbox"/>                                                                   | <input type="checkbox"/>                                                                   |

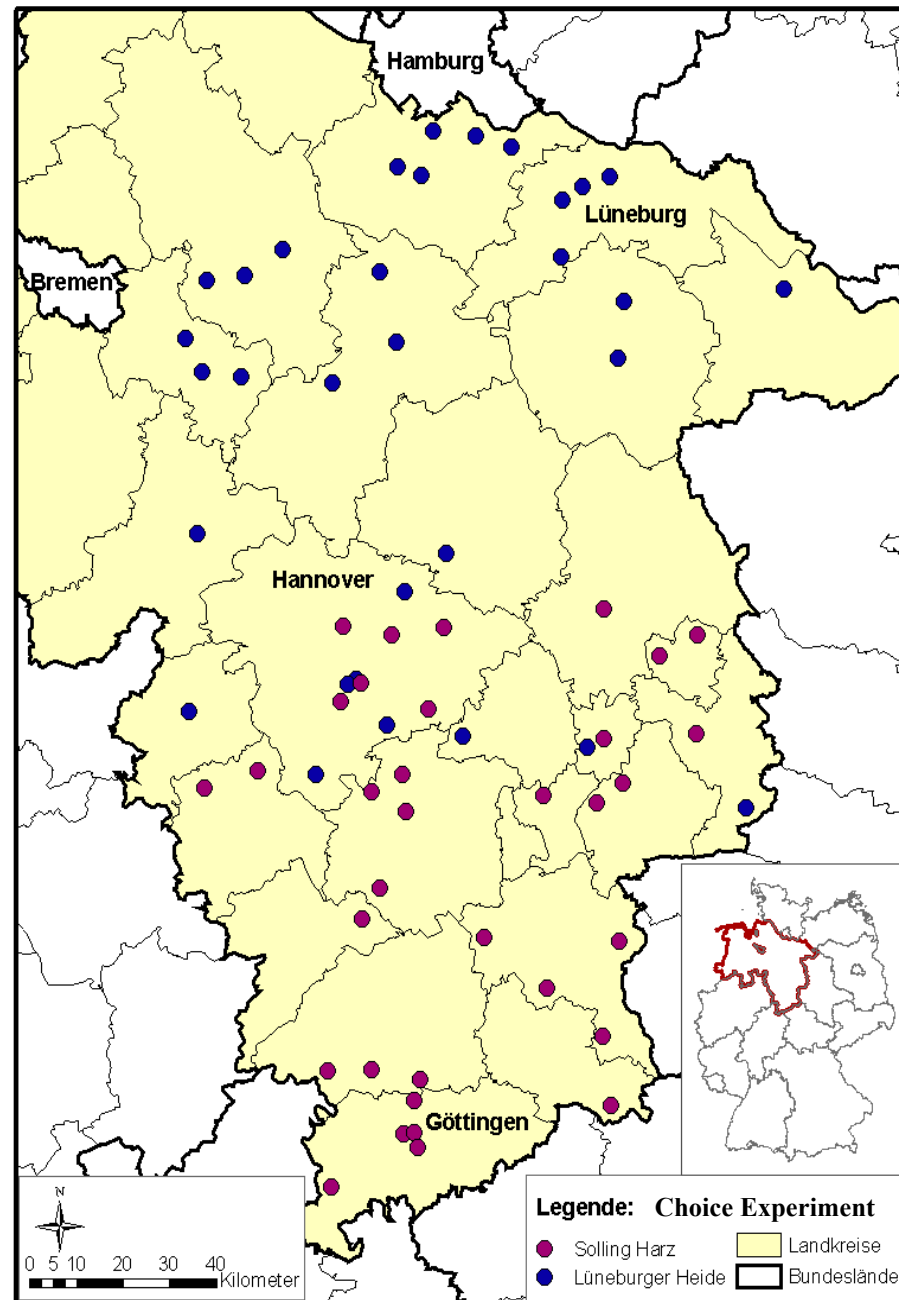
36 alternatives blocked in six subgroups - six CE per respondent





# RESULTS

# DISTRIBUTION OF INTERVIEWS



# SAMPLE CHARACTERISTICS

| Variables |                                    | <b>LH</b><br>(N = 301) | <b>SH</b><br>(N = 320) |
|-----------|------------------------------------|------------------------|------------------------|
| Socio     | Net income (€ per month)           | 2016.00                | 1954.00                |
|           | Age (in years)                     | 48.90                  | 50.05                  |
|           | Sex (Male=1)                       | 0.42                   | 0.50                   |
|           | Donation for nature protection     | 0.14                   | 0.17                   |
| Attitudes | General environmental concern      | 30.19                  | 29.33                  |
|           | Attitude toward forest conversion  | 8.49                   | 8.78                   |
| Landscape | Number of forest visits (per year) | 10.30                  | 7.00                   |
|           | Years at place of residence        | 26.82                  | 31.12                  |



# WILLING TO PAY?

| Region           | Sample<br>N | WTP yes*    |     |
|------------------|-------------|-------------|-----|
|                  |             | %           | N   |
| Lüneburger Heide | 301         | <b>40.7</b> | 121 |
| Solling / Harz   | 320         | <b>51.3</b> | 162 |

\* CE: at least one time out of six not status quo



# CONDITIONAL AND MIXED LOGIT

|                                                                     | Region 1 (LH) |     |         |     | Region 2 (SH) |     |          |     |
|---------------------------------------------------------------------|---------------|-----|---------|-----|---------------|-----|----------|-----|
|                                                                     | CL            |     | MXL     |     | CL            |     | MXL      |     |
| HAB                                                                 | 0.183         | *   | 0.545   | *** | 0.218         | *** | 0.231    | *** |
| SPD                                                                 | 0.100         |     | 0.433   | *** | 0.239         | **  | 0.362    | *** |
| FSS                                                                 | 0.148         | **  | 0.347   | *** | 0.041         |     | 0.034    |     |
| LCD                                                                 | 0.158         | **  | 0.273   | *** | 0.083         |     | 0.211    | *** |
| FOND                                                                | -0.021        | *** | -0.045  | *** | -0.022        | *** | -0.038   | *** |
| ASC <sub>SQ</sub>                                                   | 1.463         | *** | 4.791   | *** | 1.001         | *** | 2.417    | *** |
| Sigma ASC <sub>SQ</sub> *                                           |               |     | 6.924   | *** |               |     | 6.547    | *** |
| LL                                                                  | -1339.57      |     | -794.12 |     | -1639.21      |     | -1027.39 |     |
| AIC                                                                 | 2691.13       |     | 1602.23 |     | 3290.43       |     | 2068.78  |     |
| BIC                                                                 | 2723.92       |     | 1640.49 |     | 3323.58       |     | 2107.46  |     |
| Observations                                                        | 1746          |     |         |     | 1854          |     |          |     |
| CL: Conditional logit; MXL: Mixed logit with random error component |               |     |         |     |               |     |          |     |





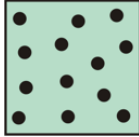
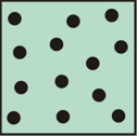
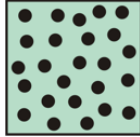
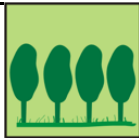
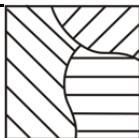
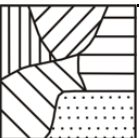
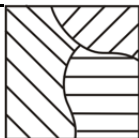
# IMPLICIT PRICES

Implicit price:  $-\beta_{\text{attribute}} / \beta_{\text{monetary attribute}}$

|     | Lüneburger Heide          |                         | Solling/Harz             |                         |
|-----|---------------------------|-------------------------|--------------------------|-------------------------|
|     | KL                        | ML                      | KL                       | ML                      |
| HAB | 8,58<br>(-6.33 / 22,03)   | 12,28<br>(2,91 / 23,47) | 9,83<br>(1,26 / 18,49)   | 6,11<br>(-0.02 / 13,32) |
| SPE | 5,25*<br>(-10,73 / 14,79) | 9,87<br>(4.02 / 15,99)  | 11,52<br>(-1,79 / 19,83) | 9,77<br>(4,29 / 16,15)  |
| FSS | 7,16<br>(-1,77 / 16,68)   | 7,74<br>(1,41 / 14,27)  | 2,16*<br>(-5,83 / 9,68)  | 1,43*<br>(-3,96 / 5.58) |
| LCD | 7,05<br>(-1,37 / 18,04)   | 5,89<br>(-0,24 / 11,17) | 4,44<br>(-2,70 / 13,10)  | 5,78<br>(-0,19 / 10,42) |



# POLICY ANALYSIS LÜNEBURGER HEIDE

| Attribute                                     | Without Forest Conversion                                                                | LOEWE                                                                                      | Protection of natural ecological processes                                                 | natural woodland                                                                          |
|-----------------------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Percentage of broad-leaved trees              | Broad-leaved trees 30 %                                                                  | Broad-leaved trees 30 %                                                                    | Broad-leaved trees ? %                                                                     | Broad-leaved trees 30 %                                                                   |
| Habitats for endangered and protected species | medium  | high     | medium  | high   |
| Number of plant and animal species            | medium  | medium   | medium  | high   |
| Forest age class                              | low     | high     | high    | high   |
| Landscape diversity                           | low    | medium  | low    | high  |
| Compensation variation in € per year          |                                                                                          | <b>33,74</b><br>(23.10 – 44.57)                                                            | <b>15.51</b><br>(3.31 – 27.84)                                                             | <b>49.07</b><br>(27.56 – 78.75)                                                           |