Determinants of demand for forest recreation : forest and population characteristics

Jens Abildtrup, Serge S. Garcia, Soren Boye S. B. Olsen, Anne Stenger

Determinants of demand for forest recreation: Forest and population characteristics

Jens Abildtrup, INRA, UMR356 LEF, F-54000 Nancy, France

Serge Garcia INRA, UMR356 LEF, F-54000 Nancy, France

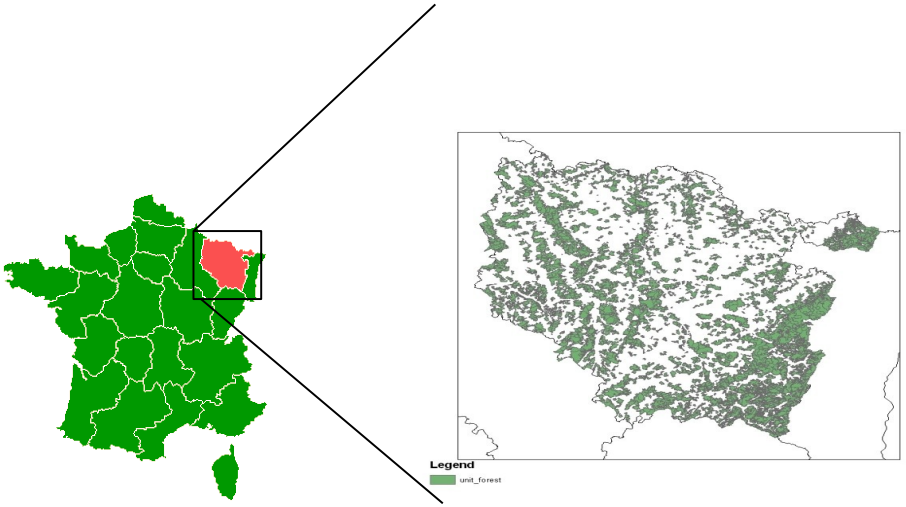
Soren Bøye Olsen, Copenhagen University, 1958 Frederiksberg C, Denmark

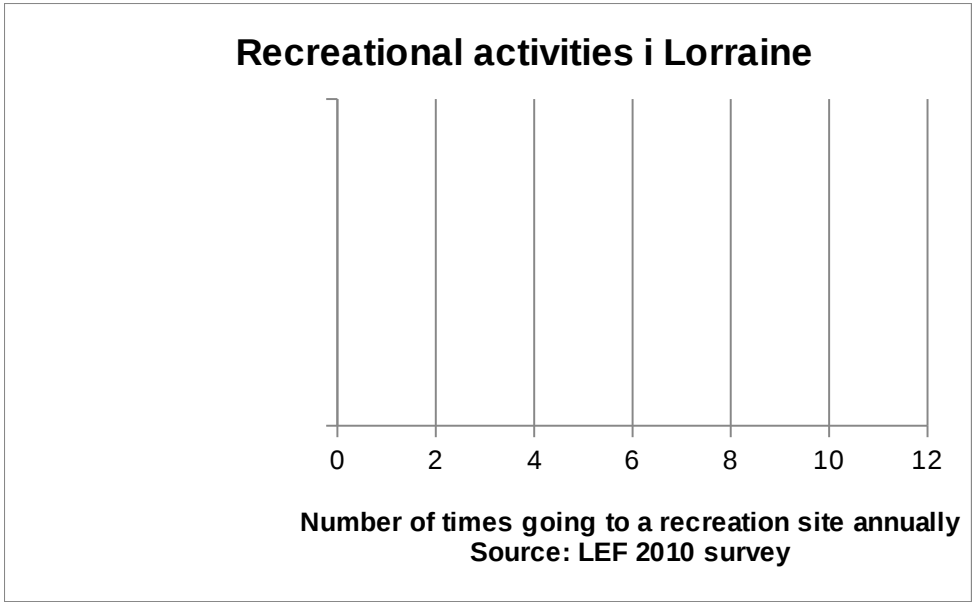
Anne Stenger INRA, UMR356 LEF, F-54000 Nancy, France

LEF workshop May 31 – June 1, 2012, Nancy

Background

- Lorraine:
  - 37 % forest (F 25%)
  - Short travel distance (13 km)
  - High frequency use of forests (26 visits per year)





Overall objectives and approach

- Estimate the determinants of demand for forest recreation
  - Forest characteristics
  - Accounting for substitution and complementary sites – spatial explicit
  - Socio-demographic characteristics of population

- Overall approach
  - Travel cost method based on revealed and stated travel behaviour
    - Data enrichment
    - Reduce problems of multicollinarity and forest attribute endogeneity

Methodological issues

- Large choice sets: >5000 forest units in Lorraine, ~ 125 different forests within 20 minutes by car
  - ⇒ Site selection model (Random utility model) and trip demand model (“linked model), Bockstael et al. 1988, Hausman et al. 1995 JPE
  - ⇒ Sampling in choice set, Feather et al. 1994 AJAE, Nerella and Bhat 2004 Trans. Res. B
  - ⇒ Identification of visited forests: Use of Google map

- Comparison of revealed and stated preferences

  =>Error component mixed logit: Bhat et Castelar 2002 Trans. Res. B, Hensher 2008, Res in Transp. Econ;

- >30% walk or go by bicycle to forest => implications for travel costs
  - ⇒ model transport mode choice explicitly, Bell and Strand 2003 Land Econ.

Outline

1. Methodology applied
2. Survey and data
3. Results
4. Discussion and perspectives

Methodology: The linked model (overview)

The linked model: e.g. Bockstael et al. 1987, Hausman et al. 1995 JPE

Stage 1: Site selection model – Random Utility Model (RUM)

Stage 2: Trip demand model – negative binominal model

The link between the two stages: Expected utility or consumer surplus of one trip

Methodology: Site selection

Combining RP and SP data. Utility by individual *n* visiting forest *j* in choice situation *t*

$$U_{ntj} = \begin{cases} \beta_n^{sp\,\prime} x_j^{sp} + \gamma_n^{sp\,\prime} p_{njt}^{sp} + \mu_h^{sp} + \varepsilon_{nst}, & j = h_1^t, h_2^t, 2, t = 1,\ldots,T^{sp}; \\ \beta_n^{sp\,\prime} x_{jt}^{sp} + \gamma_n^{sp\,\prime} p_{njt}^{sp} + \alpha_{sq} + \mu_{sq}^{sp} + \varepsilon_{njt}, & j = SQ;\ \ t = 1,\ldots,T^{sp}; \\ \beta_n^{rp\,\prime} x_j^{rp} + \gamma_n^{rp\,\prime} p_{njt}^{rp} + \varepsilon_{njt}, & j = 1,\ldots CS^{rp},\ \ t = T^{sp}+1 \end{cases}$$

SP

RP

$\beta_n\ \gamma_{nm}$: parameters of the indirect utility function for individual *n* and mode *m*

μ_h^{sp} : an error component μ_h^{sp} : $N(0,\sigma_{\mu_h^{sp}})$ for hypothetical forest in CE

μ_{sq}^{sp} : an error component μ_{sq}^{sp} : $N(0,\sigma_{\mu_h^{sp}})$ for visited forest in CE

α_{car} : constant utility related to choice of status quo (most visited forest during the last 12 months

x_j : the forest attributes for forest j

p_{njt}: Travel cost (distance between individ *n* and forest *j*)

ε_{njm} : an unobserved error term

Methodology: Site and transport mode selection

The utility function for individual *n* for visiting forest *j* with transport mode *m*

$$V_{njm} = \beta_n' x_j + \gamma_{nm}' p_{njm} + (\alpha_{car} + \mu_n) d_{jm} + \varepsilon_{njm} \text{ for } j = 1,...J, \quad n = 1,...N, \text{ and } m = \{car, walk\}$$

where $d_{jwalk} = 0$ and $d_{jcar} = 1$

β_n γ_{nm} : parameters of the indirect utility function for individual *n* and mode *m*

μ_n : an error component : $N(0, \sigma_\mu)$

α_{car} : constant utility related to mode choice (car)

x_j : the forest attributes for forest *k*

p_{njm} : the travel cost for visiting forest *j* with mode *m* by individ *n*

ε_{njm} : an unobserved error term

Methodology: The linked model

Assuming *εnk* is i.i.d. extreme value the expected maximum utility of one trip to a forest (the link):

$$V_n(\beta_n) = \ln \sum_m \sum_j^J e^{V_{njm}} + K = \text{ inclusive value + constant}$$

Assuming random parameters the expected value should be simulated using estimated parameter distributions:

Methodology: The linked model II

1. Trip demand model: negative binominal model

Where the probability of *tn* visits in forest during 12 months is

$$\Pr\left(t_n \middle| s_n, z_n, u_n\right) = \frac{e^{-\lambda_n u_n}(\lambda_n u_n)^{t_n}}{t_n!}$$

Where $\lambda_n u_n = e^{\gamma s_n + z_n \delta + \varphi_n}$

s_n is the inclusive value in commune of respondent *n*

z_n are variables describing the respondent and the local environment

u_n is an unobserved error term e^{ϕ_n} which is assumed to be gamma distributed

$\lambda_n = e^{\gamma s_n + \delta z_n}$

Using cluster (canton) robust error estimation

Data: The survey

- Web-based questionnaire send to random sample in Lorraine 2010:
  - Previous use of forests for recreation
  - Choice experiment on hypothetical use of forests
  - Characteristics of the respondent
    - Location identified by municipality (*commune* Small administrative unit)

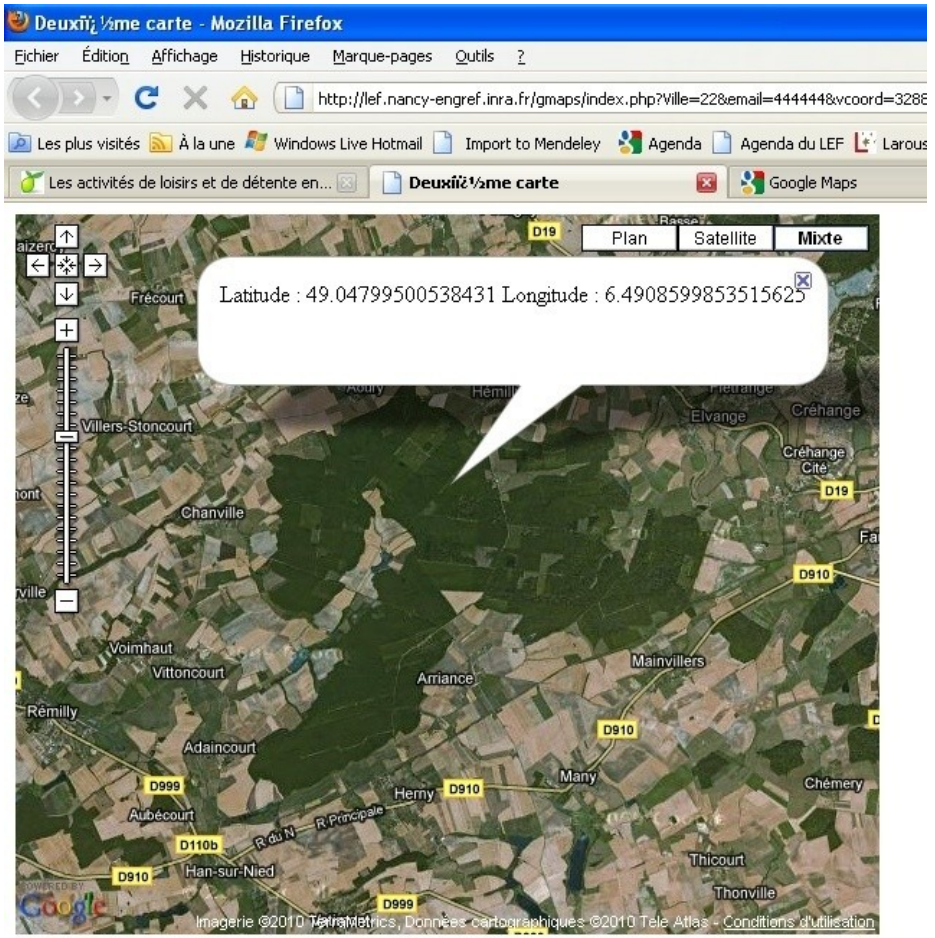
The survey

Where is the forest located where you have gone most often during the last 12 months ?

Click on the the forest on the map

Self-reporting:

I have found the forest	88.9%
I didn't find the forest because it was to difficult	6.5%
I have not found the forest because it was the map was not appropriate for locating the forest	4.6%

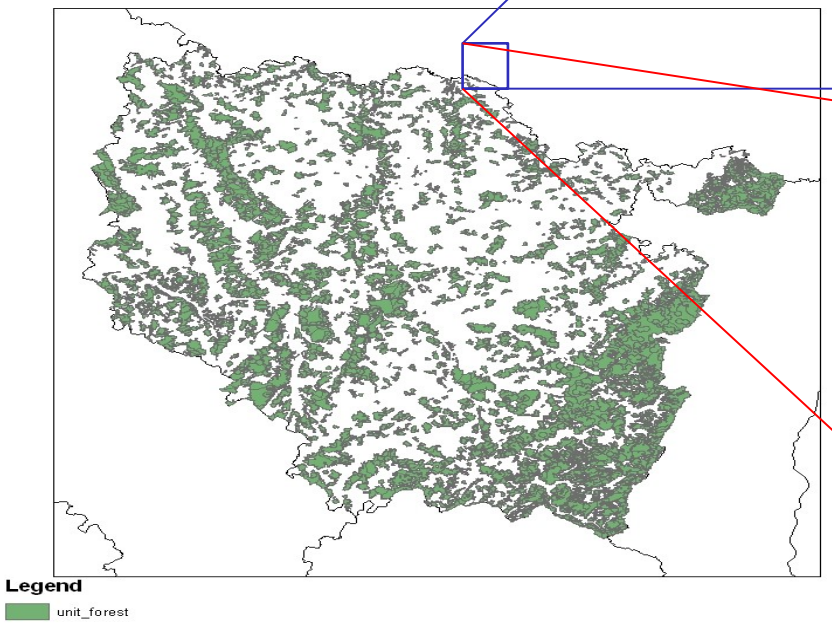


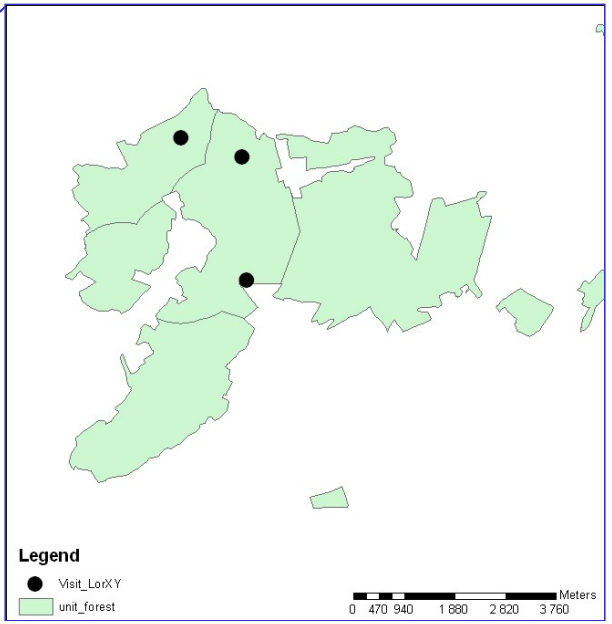
1 Vous pouvez maintenant fermer cette fenetre pour revenir au questionnaire

The survey

Defining a forest relevant recreation?

Forests in Lorraine





Google Map

Where the forest are located

Choice set example

Choose the forest you would have gone to if the two alternative forest existed when you went to the forest the last year

Characteristics of the forests	The forest you visited most often the last year	Alternative 1	Alternative 2
Dominant tree species	Mixed tree species	Mixed tree species	Conifers
Trekking paths	One path	No paths	More paths
Recreational facilities	Parking	No	Parking and picnic
Access to wetland	No water	Lake or river	No water
Distance from your home	13 km	5 km	20 km
I prefer …(tick one):	□	□	□

Attributes

Describe the forest you have visited most often the last 12 months	
Tree species	***Cochez une possibilité***
	Broadleaves ❑
	Conifers ❑
	Mixed species ❑
Trekking paths	***Cochez une possibilité***
	No trekking paths ❑
	One trekking path ❑
	More than one trekking path ❑
Facilities	***Cochez une possibilité***
	none ❑
	Parking ❑
	Picnic ❑
	Parking and picnic ❑
Water	***Cochez une possibilité***
	no ❑

Data: Sample representativeness

818 usable responses
(526 had visited forest and had identified visited forest)

2% response rate
(as expected from this internet panel)

Overweight of

- Males
- Elderly males
- Middle-aged females
- High income

Results – common SP and RP parameters

	Random parameters SP and RP data		Derived standard deviations of parameter distributions		
Variable	Coefficient	P[|Z|>z]	Coefficient	P[|Z|>z]	
Broadleaves	**0.79 *** **	**0.000**	**0.49 *** **	**0.002**	RP & SP
Mixed species	**0.90 *** **	**0.000**	**0.86 *** **	**0.000**	
One trekking path	**0.55 *** **	**0.000**	**0.40 *** **	**0.009**	
More than one trekking road	**0.72 *** **	**0.000**	**0.89 *** **	**0.000**	
Parking or picnic	**0.21 ** **	**0.016**	**0.57 *** **	**0.001**	
Parking and picnic	0.15	0.113	**0.85**	**0.000**	
Lake and/or river	**0.63 *** **	**0.000**	**0.47 *** **	**0.000**	
Distance (km)	**-0.13 *** **	**0.000**	**0.13 *** **	**0.000**	
Private forest	**-0.45 *** **	**0.012**	0.01	0.979	RP
Private and public forest	-0.21	0.110	0.17	0.415	
Standard dev. of altitude	0.00	0.976	0.00	0.888	
Log(area)	**0.66 *** **	**0.000**	0.00	0.974	
Probability of finding blueberries	0.47	0.597	0.35	0.791	
ASC1 (Status quo alternative)	**0.39 *** **	**0.000**	**0.91 *** **	**0.000**	
ASC2	0.00		**2.0**	**0.000**	
McFadden Pseudo R-squared		0.72			

*: p<0.1, **: p<0.05, ***: p<0.01

N=526 Number of choices =526*7=3682

Results: SP and RP

Variable	Coefficient		P[|Z|>z]	Coefficient		P[|Z|>z]
	SP data			RP data		
Broadleaves	0.78	***	0.0000	0.45		0.3366
Mixed species	1.01	***	0.0000	0.60		0.1421
One trekking path	0.39	***	0.0000	0.53	***	0.0038
More than one trekking road	0.61	***	0.0000	0.33		0.1774
Parking or picnic	0.11		0.1831	0.68	***	0.0099
Parking and picnic	0.077		0.3806	0.78	***	0.0069
Lake and/or river	0.64	***	0.0000	0.38	**	0.0348
Distance (km)	-0.044	***	0.0000	-0.38	***	0.0000
Private forest				-0.59	**	0.0189
Private and public forest				-0.27		0.1450
Standard dev. of altitude				-0.0087		0.1204
Log(area)				0.82	***	0.0000
Probability of finding blueberries				1.71		0.2144
ASC1 (Status quo alternative)	0.458	***	0.000			

*: p<0.1, **: p<0.05, ***: p<0.01

Comparison of marginal WTP (Unit=km)

Variable	Dataset-specific parameters		Common parameters	
	WTP **SP** data	WTP **RP** data	WTP **RP & SP** data	
Broadleaves	**19.47**	1.24	**7.79**	RP & SP
Mixed species	**24.22**	1.8	**8.65**	
One trekking path	**9.81**	**1.71**	**6.18**	
More than one trekking road	**15.33**	1.11	**6.99**	
Parking or picnic	2.68	**2.32**	**1.95**	
Parking and picnic	2.80	**2.6**	1.68	
Lake and/or river	**14.80**	**1.26**	**6.24**	
Distance (km)	-	-	-	
Private forest		**-1.93**	**-4.43**	
Private and public forest		-0.77	-2.23	RP
Standard dev. of altitude		-0.03	0.00	
Log(area)		**2.60**	**6.78**	
Probability of finding blueberries		2.97	6.35	
ASC1 (Status quo alternative)	**1.50**		**5.49**	
ASC2				

NB: Bold numbers: where marginal utility is significant – significance of the marginal WTP has not been tested explicitly

Results: RP data, Transport mode choice

Variable	Coefficient		P[|Z|>z]
Broadleaves	0.29		0.573
Mixed species	0.42		0.389
One trekking path	0.71	***	0.094
More than one trekking road	0.077		0.771
Trekker*one trekking path	2.1	***	0.003
Trekker*more trekking paths	0.83		0.454
Parking	0.92	***	0.001
Lake and/or river	0.038		0.839
Travel cost car (car cost and time cost)	-0.47	***	0.000
Travel cost walking (alternative time cost)	-0.10	***	0.000
Private forest	-0.87	***	0.003
Private and public forest	-0.48	**	0.015
Standard dev. of altitude	-0.001		0.934
Log(area)	0.80	***	0.000
Number of attractions	0.026		0.542
ASC for car mode	-3.0	***	0.000
McFadden Pseudo R-squared	0.56		
N=526 Number of choices=526			

Trip model – number of visits in forest

Variable	Coefficient	P[|Z|>z]
Constant	1.63***	0.007
Inclusive value	0.09***	0.009
Population density	-0.019	0.361
Share of urban green space in the town	-0.29	0.893
Income	-0.034**	0.048
Female	-0.48***	0.000
Hunter	0.86***	0.000
Forest owner	0.45***	0.001
Higher education	0.14	0.189
Lives in an apartment	-0.21***	0.052
Often buying organic products	0.20***	0.000
Member of a trekking club	0.55***	0.001
Lives with a partner	-0.24**	0.013
Alpha (over dispersion)	1.40 ***	0.000
N	818	

Trip model – number of visits in urban parks

Variable	Coefficient	P[|Z|>z]
Constant	0.24	0.814
Inclusive value	-0.048	0.450
Income	0.13**	0.000
Female	0.075	0.609
Hunter	-0.10	0.786
Forest owner	-0.85***	0.006
Higher education	0.024	0.861
Lives in an apartment	0.52***	0.000
Often buying organic products	0.11***	0.054
Member of a trekking club	0.39	0.239
Lives with a partner	0.24	0.154
Population density	0.27***	0.000
Share of urban green space in the town	0.57	0.828
Alpha (over dispersion)	3.1 ***	0.000
N	818	

Trip model – number of visits in urban parks

Variable	Coefficient	P[|Z|>z]
Constant	-0.25	0.455
Share of forest in municipality	-0.82**	0.024
Income	0.12***	0.000
Female	0.11	0.480
Hunter	-0.076	0.820
Forest owner	-0.80**	0.012
Higher education	0.083	0.572
Lives in an apartment	0.56***	0.000
Often buying organic products	0.12**	0.033
Member of a trekking club	0.43	0.159
Lives with a partner	0.27	0.103
Population density	0.22***	0.000
Share of urban green space in the town	0.14	0.955
Alpha (over dispersion)	3.1 ***	0.000
N	818	

Discussion and perspectives

- People (our sample) can identify a visited forest on a (*Google*) map
- Results based on stated and revealed preferences data differ in our case
  - What data to use for policy analysis?
- Possible to cope with transport mode choice explicitly in a RPL model