EFFECTS OF DIFFERENT FOREST CONVERSION PRACTICES ON NITROGEN FLUXES IN AN N-SATURATED SPRUCE FOREST ECOSYSTEM

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Experiment

Question: How do different forest conversion practices (clear cut, selective cutting) affect N cycling (N input, functional microbial biodiversity, microbial N turnover, N trace gas exchange, nitrate leaching) in an N-loaded spruce forest ecosystem?

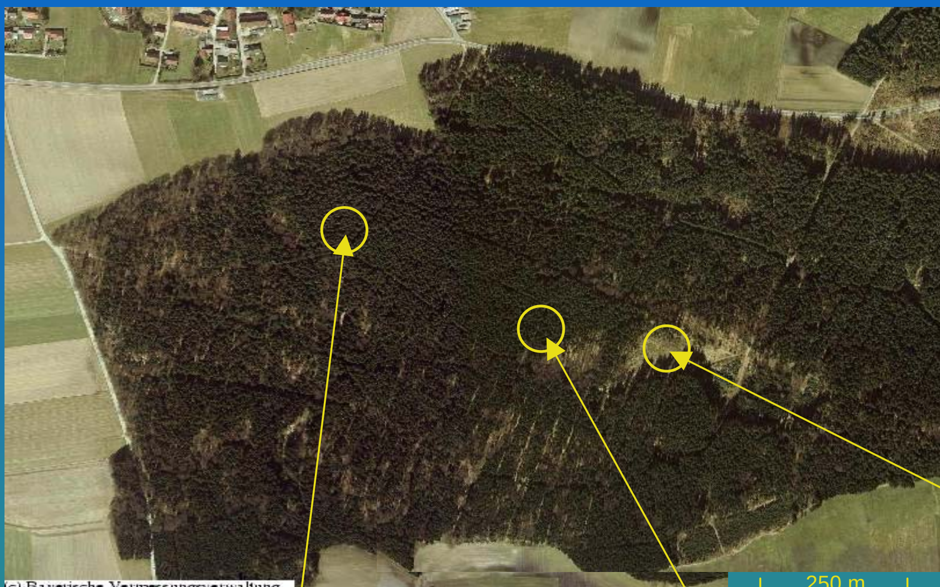
Design: Experiment in an approx. 110-yr-old Norway spruce forest
- Control site without treatment (last thinning 1975)
- area of 1 ha with selective cutting (removal of 20 %)
- area of 1 ha, clear-cut

Measurements:
- N input in throughfall
- Cell numbers of microbial populations (AHB, AHN, CNO, DEN)
- Microbial biomass
- Microbial N turnover (N mineralization, nitrification, denitrification, microbial N immobilization)
- Soil C and N trace gas exchange (CO_2, CH_4, NO, NO_2, N_2O, N_2)
- Nitrate and metal cation concentrations in seepage water

Start: 1999 (pre-treatment phase)

Cutting: End of February 2000

Experimental site: Höglwald



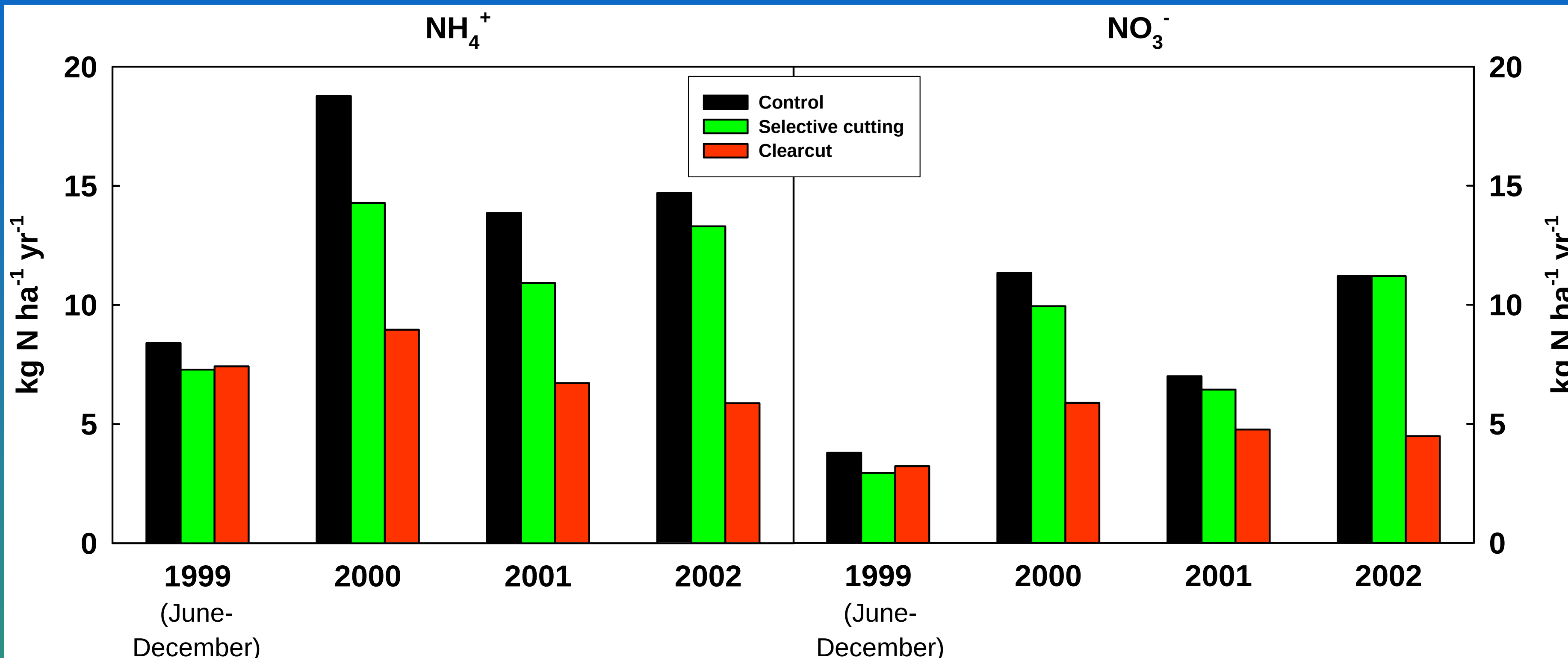
Forest:	Approx. 100-yr-old spruce
Location:	11°11‘E, 48°30‘N
Elevation:	540 m.a.s.l.
Climate:	Suboceanic
Mean annual temperature:	7.7 °C (1984-2001)
Mean annual precipitation:	933 mm (1984-2001)
Vegetation zone:	Temperate broad-leaf zone
Soil type:	Typic Hapludalf (USGS) Dystric Cambisol (FAO)
Humus type:	Moder (~7 cm)
pH in $CaCl_2$:	< 3 (organic layer) < 4 (A horizon)
Proportion of agricultural land to forest:	~2:1

Spruce control

Selective cutting

Clearcut

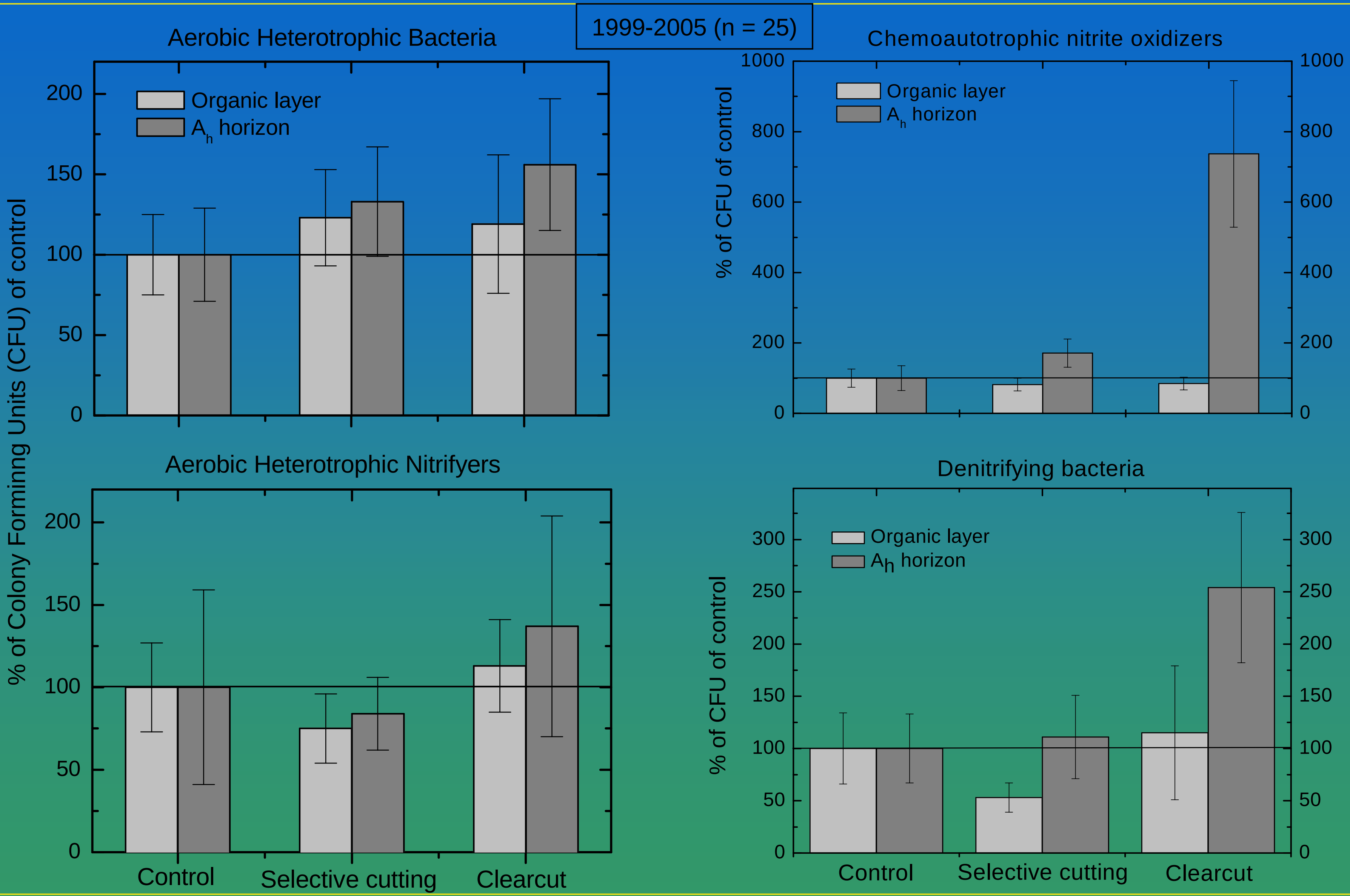
N input via throughfall



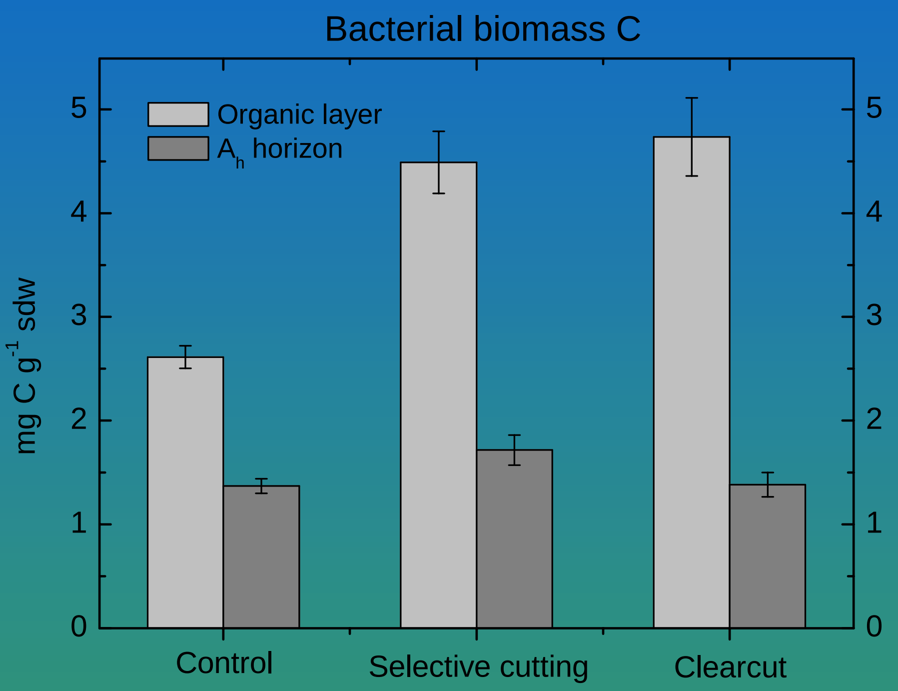
Treatment	1999 (6-12)	2000	2001	2002
Control	12.2	30.1	20.9	25.9
Selected cutting	10.2	24.2	17.4	24.5
Clear-cut	10.6	14.8	11.5	10.4

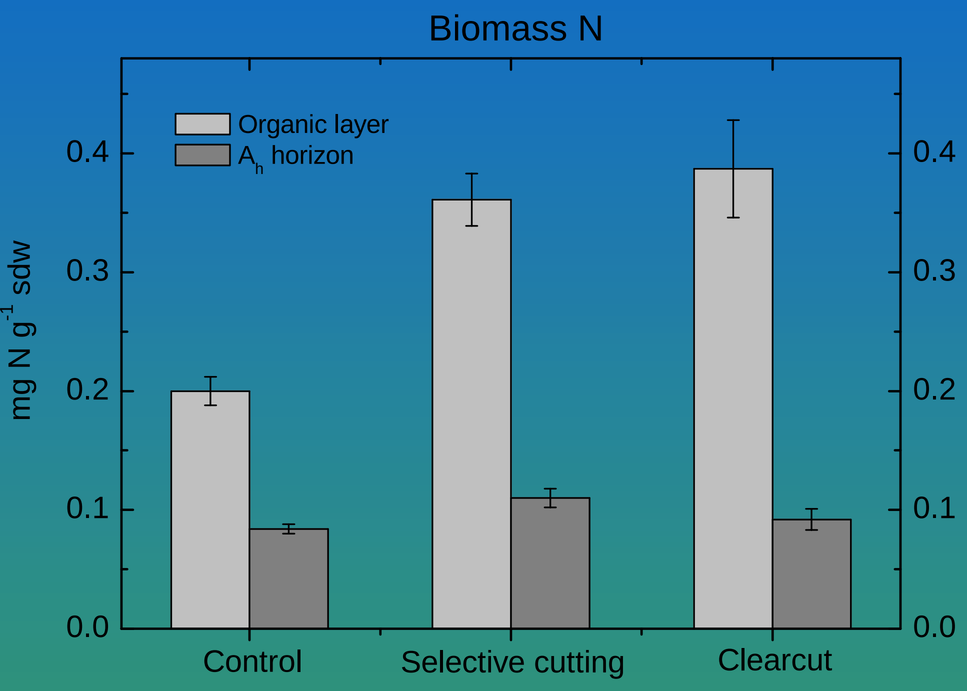
Huber et al. (2004), *Plant and Soil* **267**, 23-40.

Functional groups of microbes involved in N turnover



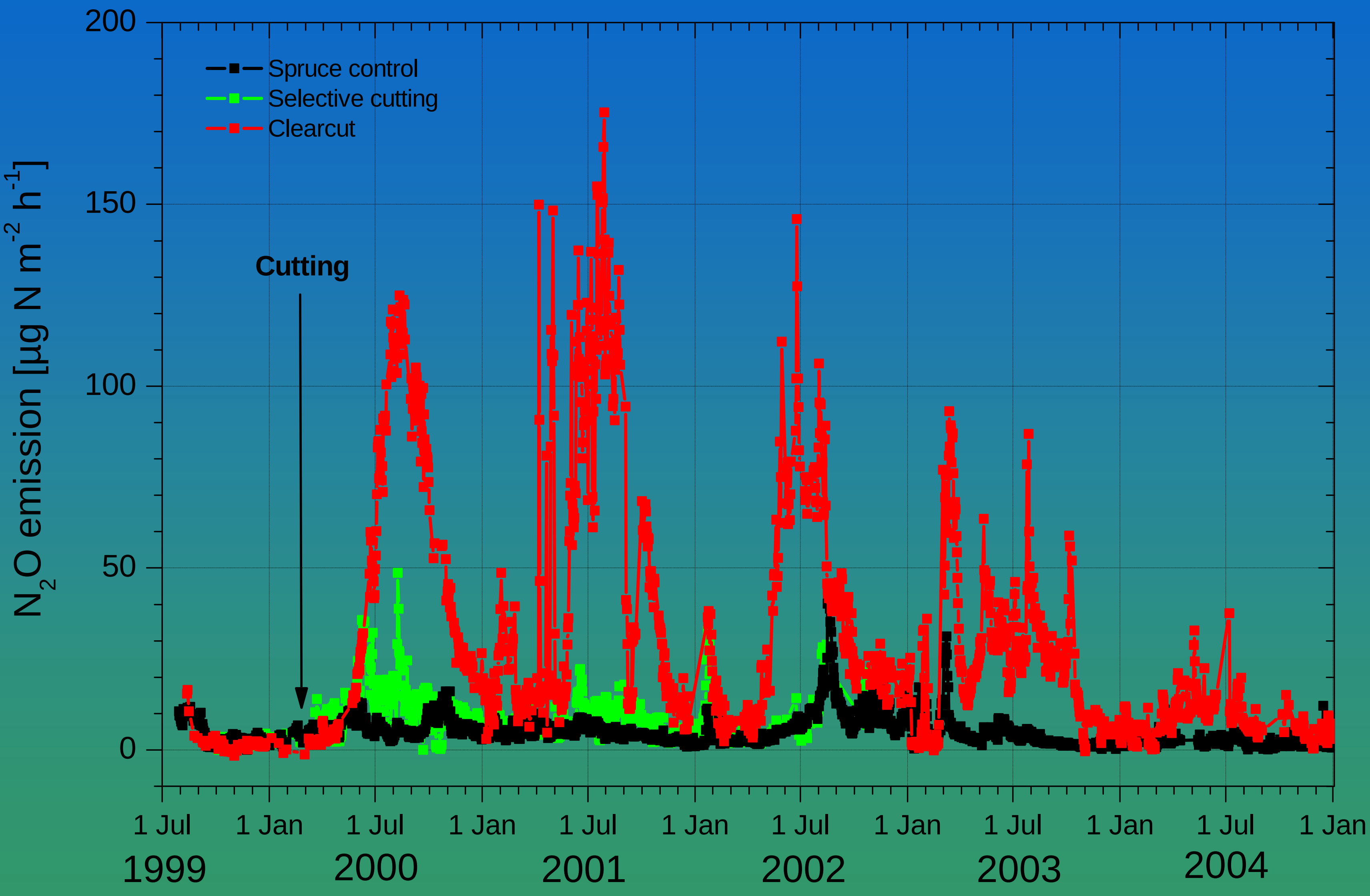
Bacterial biomass C and N



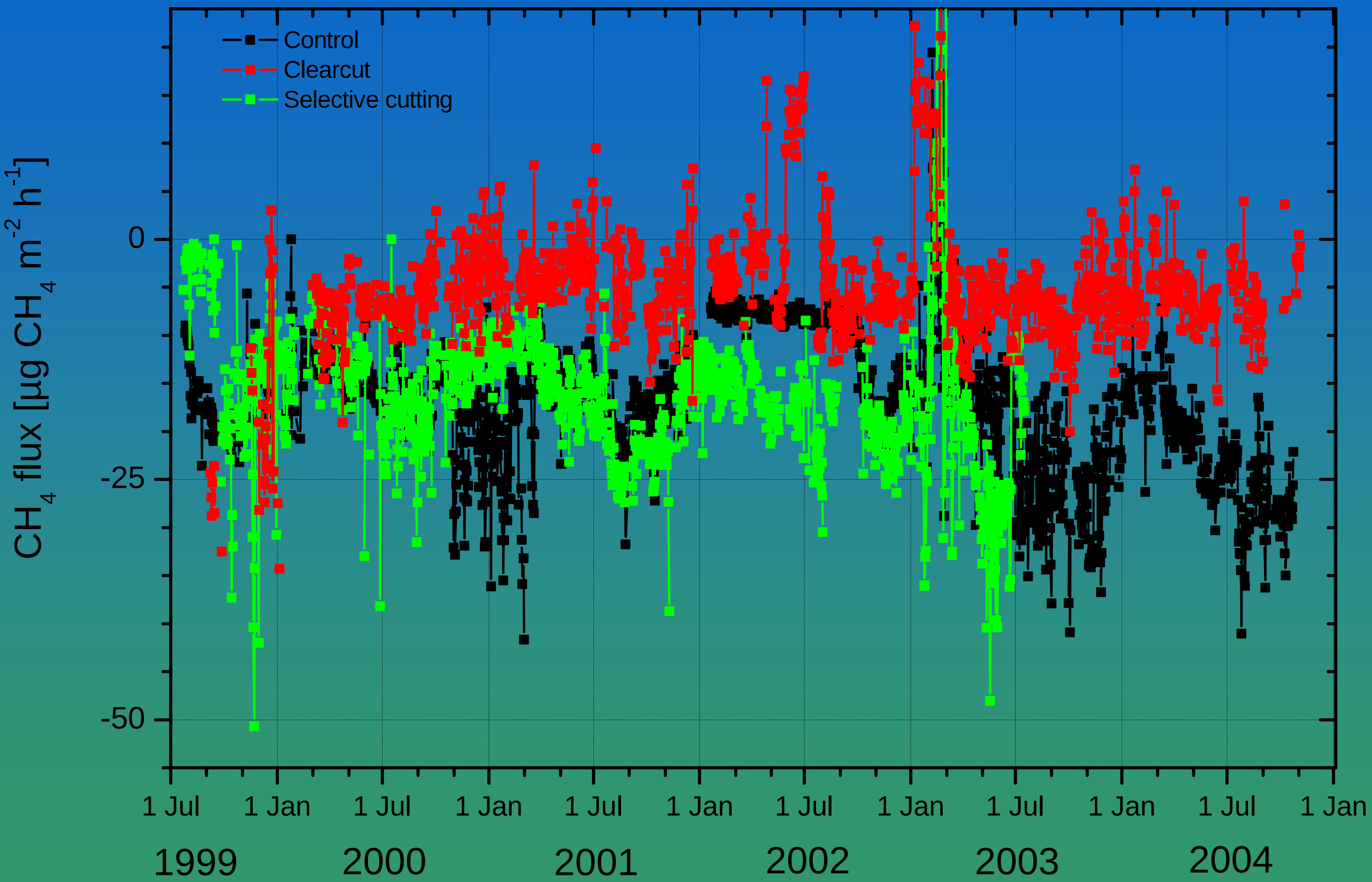


1999-2005 (n = 25, fumigation-extraction)

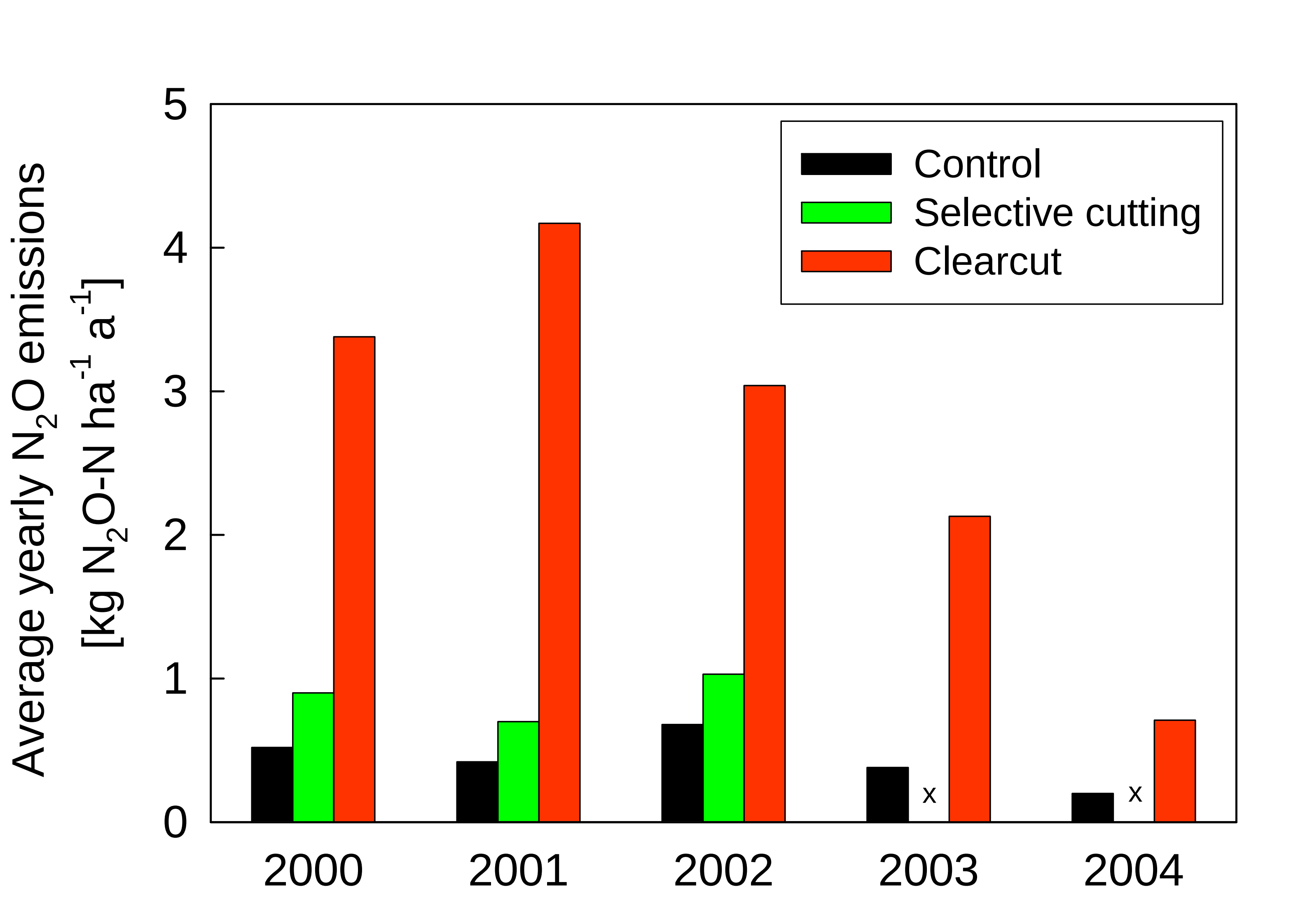
N_2O fluxes: Daily means



CH_4 fluxes: Daily means

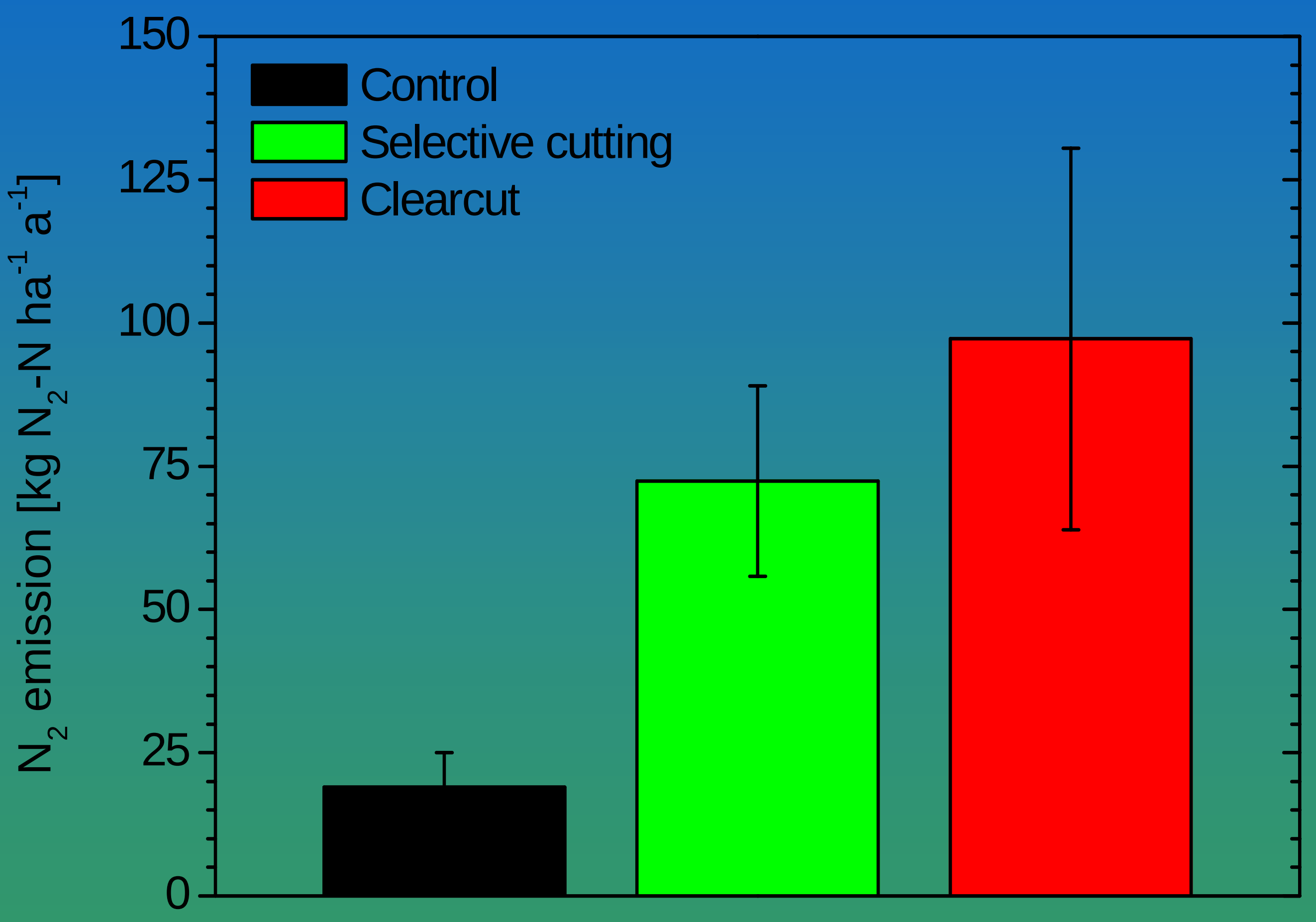


N_2O fluxes: annual means

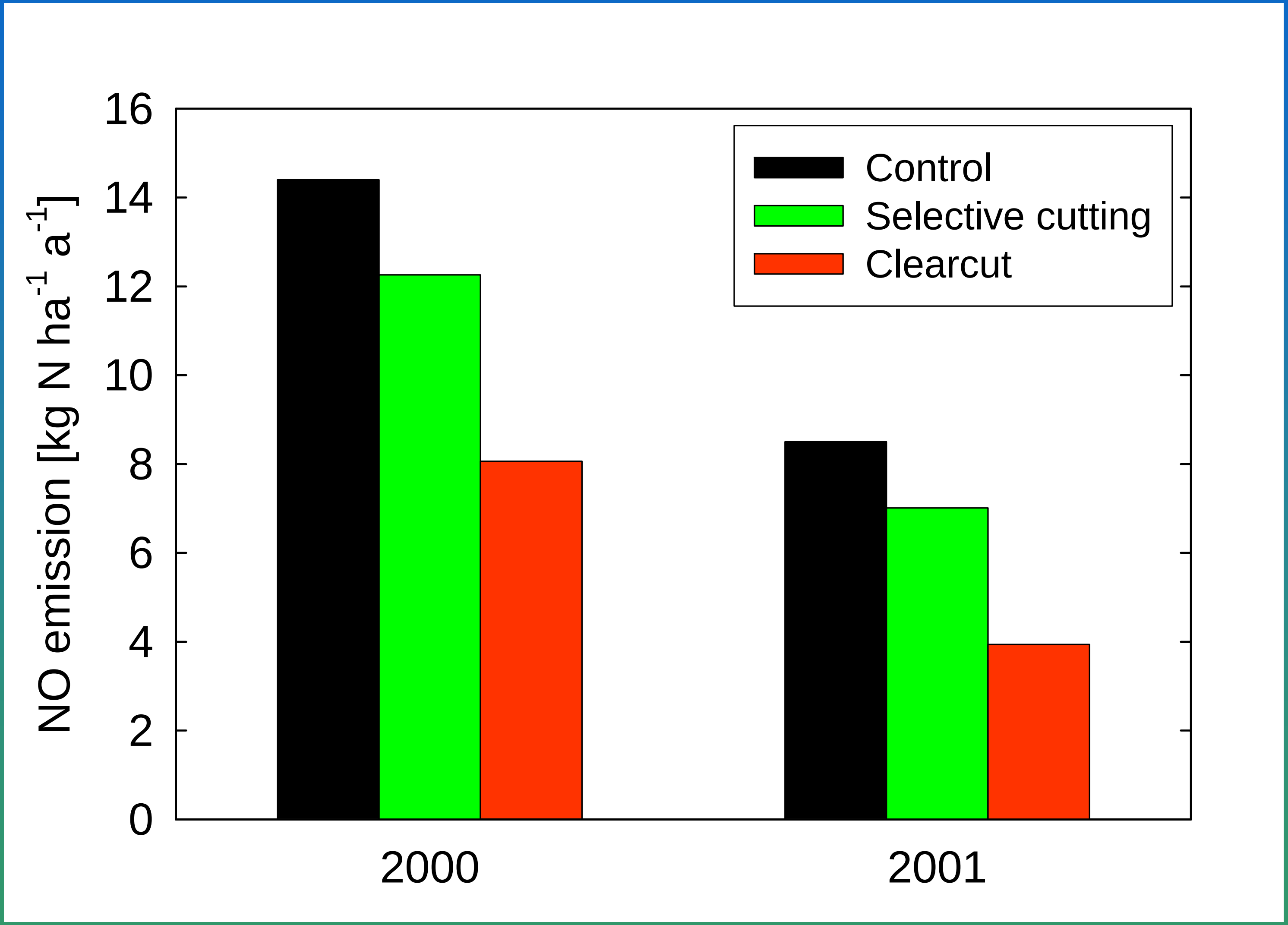


N_2 fluxes: mean of 2000-2001

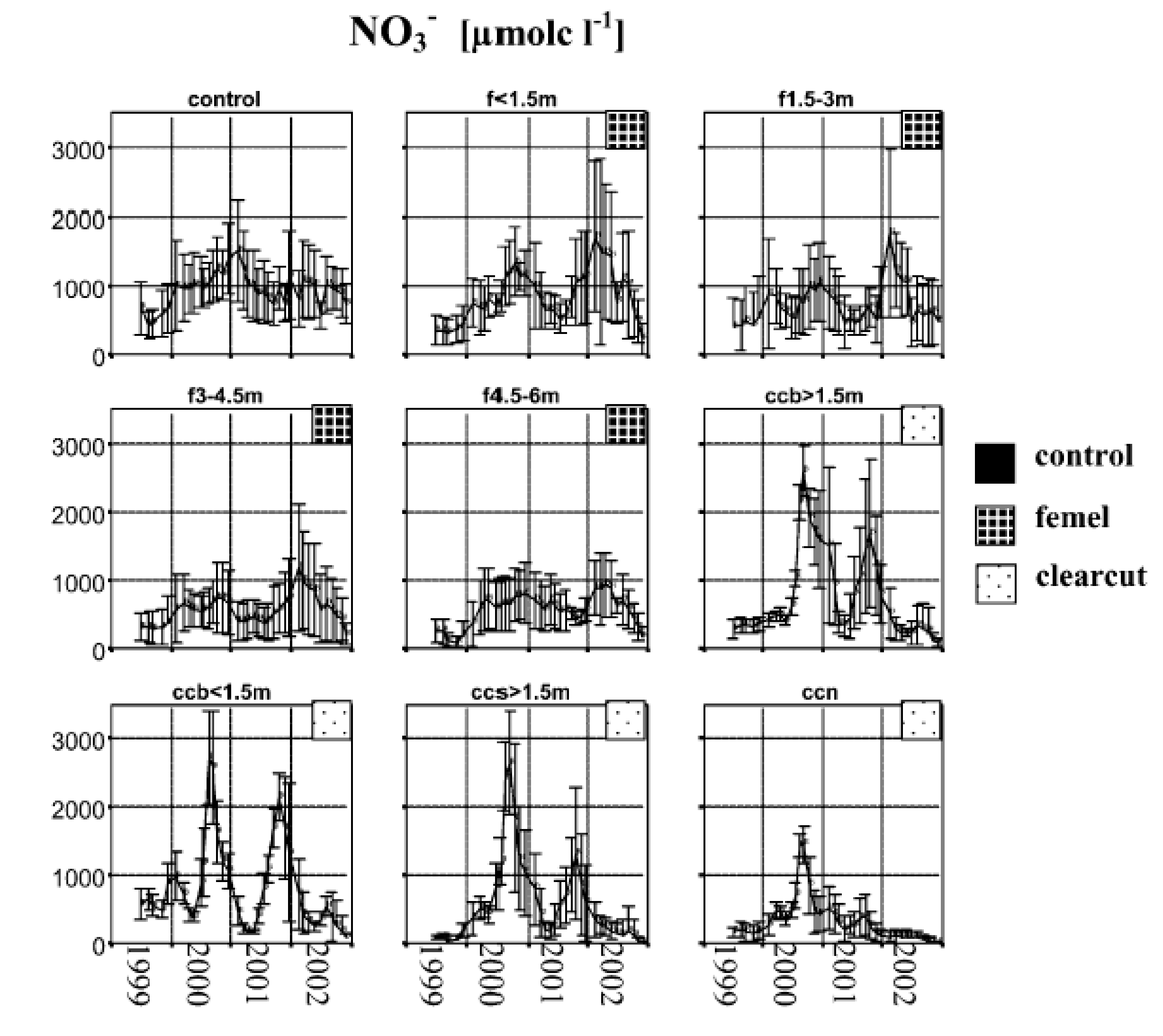
Results from laboratory incubation studies: GC analysis of the N_2 formed in intact soil cores.



NO/NO_2 fluxes: annual means



Nitrate in seepage water



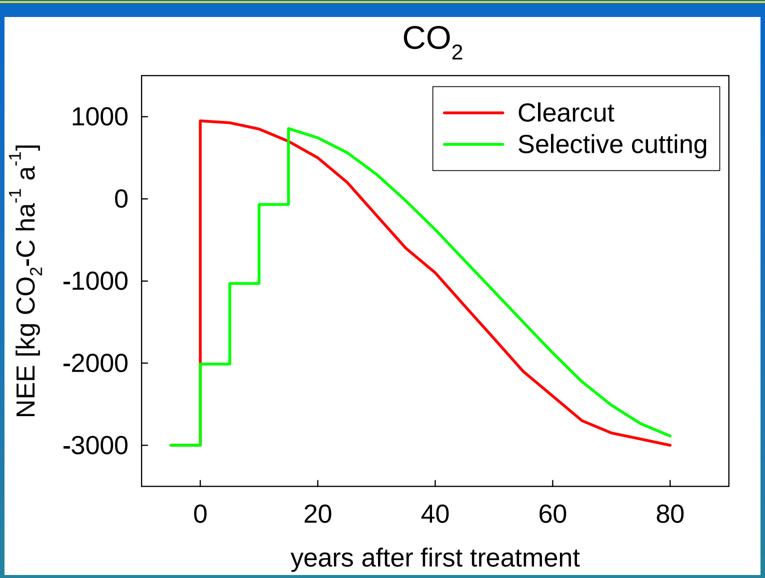
Nitrate concentrations in seepage water (40 cm depth)

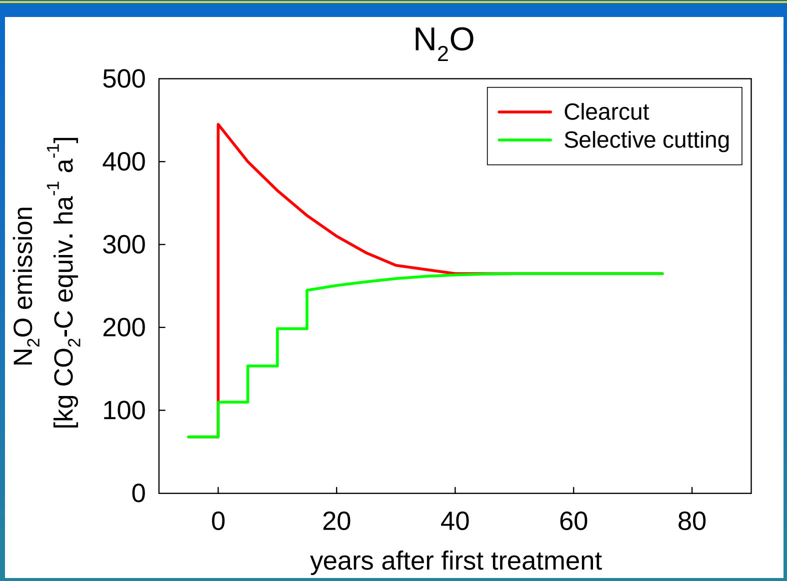
- **enhanced** under the clear-cut area in the first and second year after the treatment

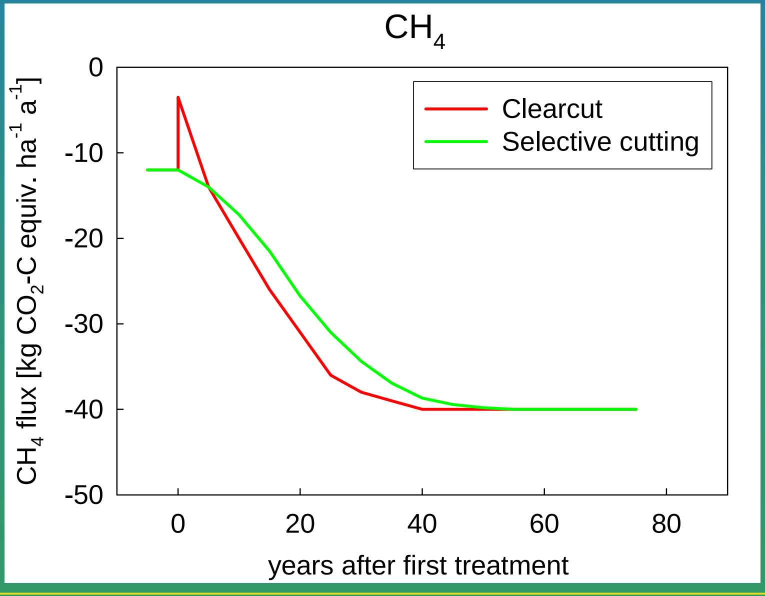
- **lower** in the third year as compared to the control and selective cutting area.

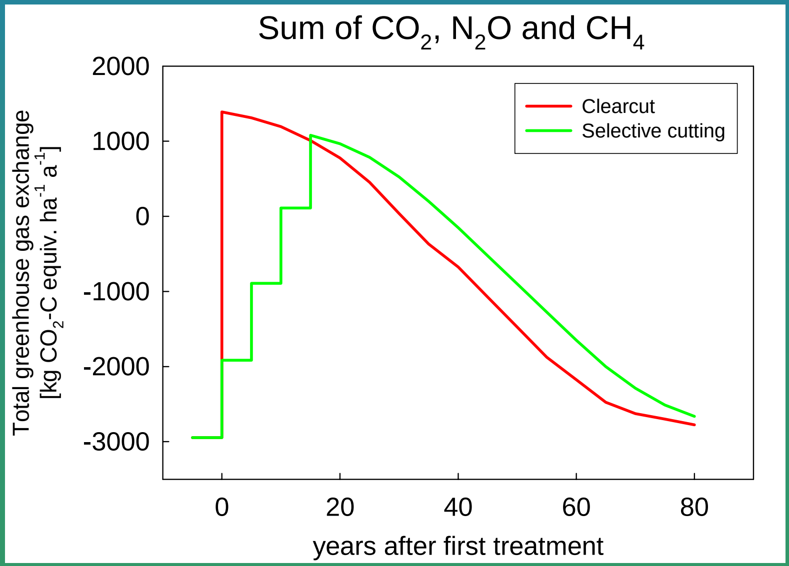
Huber et al. (2004),
Plant and Soil **267**, 23-40.

Calculated greenhouse gas budgets of forest conversion over a period of 80 years

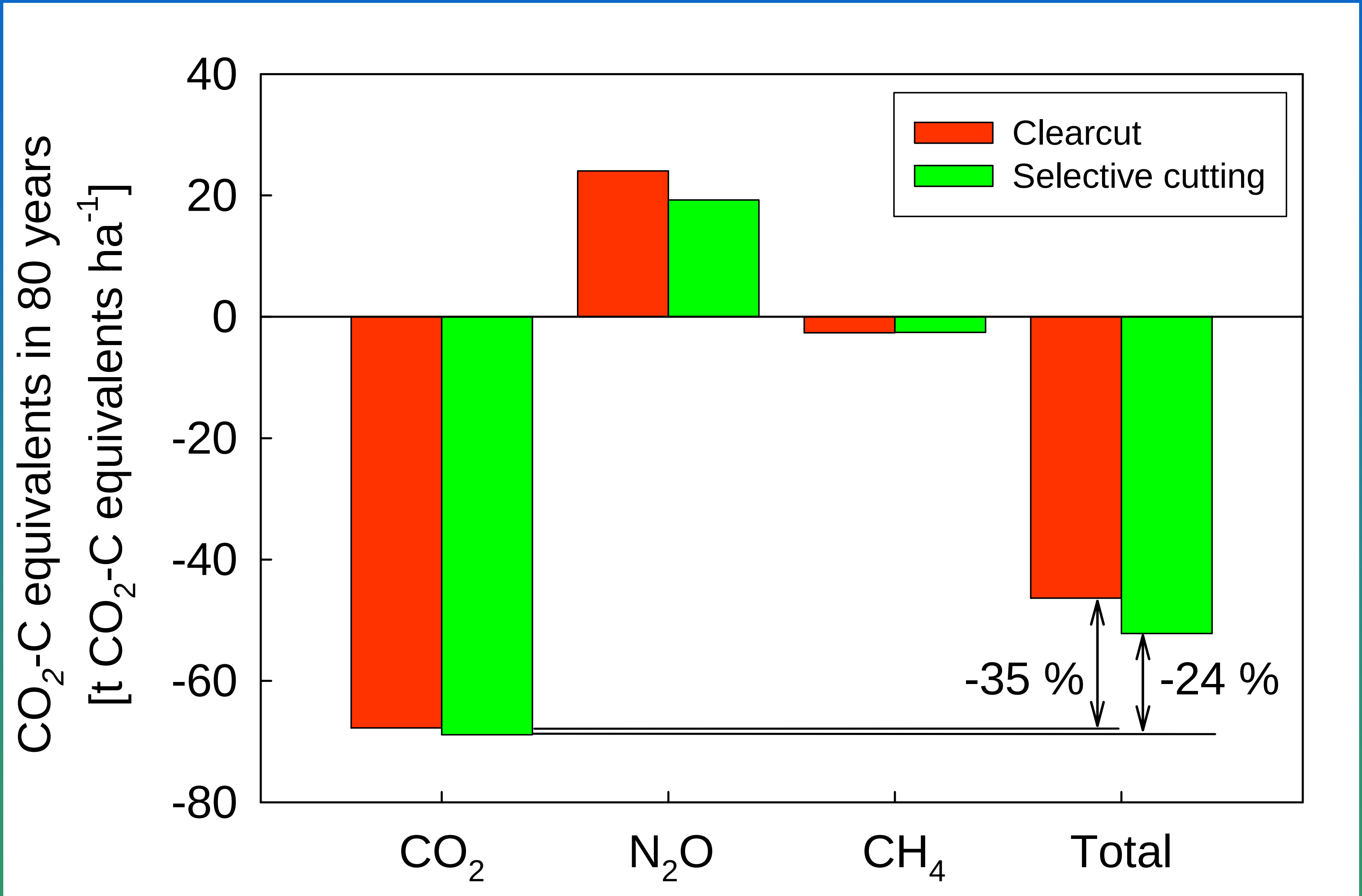








Calculated total greenhouse gas budget of forest conversion over a period of 80 years



Summary and conclusions

- **N input** via throughfall was **significantly reduced** after clear-cutting compared to selective cutting and untreated control
- Populations of **chemoautotrophic nitrite oxidizers** and **denitrifiers** were significantly **enhanced** in the soil after clearcut, especially in the mineral soil
- Clearcut led to an **extreme stimulation of N_2O emissions** over four years, but only to a slight increase in the selective cutting plot
- **CH_4 uptake** is still **significantly lower** in the clearcut area even after five years
- **N_2 formation** was **extremely stimulated** at least two years after clearcut, but also very high in the selective cutting area
- **NO emissions** were **substantially reduced** in the clearcut plot compared to control and selective cutting
- **Nitrate leaching** was **much higher** in the clearcut plot than in the two others in the year of the treatment and in the year after, but lower afterwards
- **Total greenhouse gas sink strength** of the forest over a period of 80 years **reduced** by approx. **35 % by clear-cutting** as compared to approx. **24 % by selective cutting**