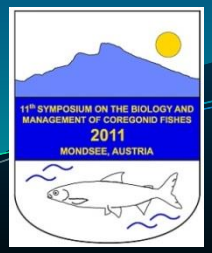


Institute for Limnology
www.oeaw.ac.at/limno

Population projection matrix models (PPMs) for European lake whitefish derived from gillnet catch data corrected by the SELECT-method

Harald Ficker

Supervisor: Univ. Doz. Dr. Josef Wanzenböck

Part of project **RADICAL**:

Funding:

Austrian Climate Research Programm (ACRP)

klima+ energie fonds

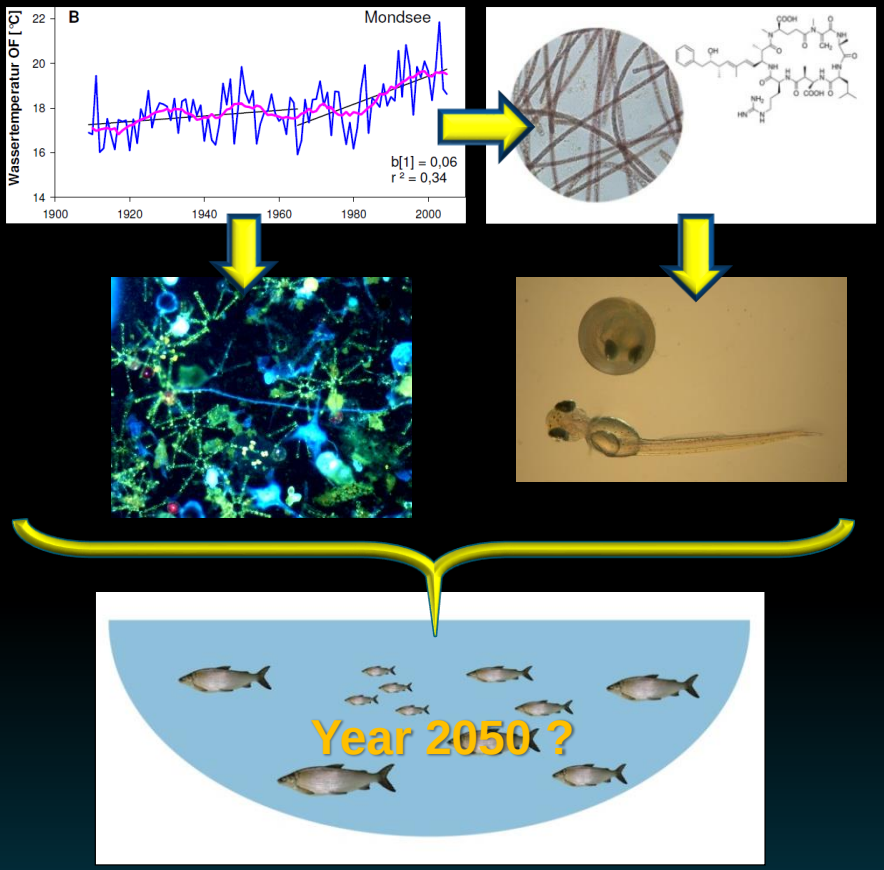
ÖAW Austrian Academy of Sciences

Austrian Academy of Sciences, Institute for Limnology, Ecology of freshwater fish

Project RADICAL

Aim is to estimate the direct and indirect consequences of a changing climate on whitefish populations of pre-alpine lakes by analysing:

- the effects of regional climate change on phytoplankton development,
- the exposure of early life stages of whitefish to toxic cyanobacteria at chronic/subchronic levels,
- the demographic consequences for autochthonous and introduced whitefish populations over the next decades under various climate scenarios and ecotoxic effects of cyanobacteria (**population model**).



Suiteable models for fish populations

- Differential equations (DEs)
- Individual based models (IBMs)
- Bioenergetics models (BEMs)
- Population projection matrix models (PPMs)
- Integral projection models (IPMs)
- Model combinations

Population projection matrix models (PPMs)

Well approved for fish populations in the context of conservation, management and risk analysis.

Model ability meets project RADICAL requirements by incorporation of:

- Toxicity (e.g. Van Kirk & Hill 2006)
- Climate change (e.g. Hunter et al. 2010)
- Density dependence (e.g. Sable & Rose, 2010)
- Population management (e.g. Chizinski et al. 2010)
- Stochasticity (e.g. Sakaris & Irvin 2010)

Population projection matrix models (PPMs)

Population demography divided into discrete classes (e.g. age, length,…), with specific vital rates (survival, fertility) for matrix calculations.

Elementary PPM structure and dimension influence modeling results!

- **Vital rate estimation for PPM of the studied whitefish population?**
- **What are the differences between various PPM structures and dimensions for coregonid populations?**
- **How to verify PPM results for whitefish populations?**

Population of *C. maraena* in Lake Irrsee

Life-table construction
by analyzing gillnet catches with multiple mesh sizes over a period of 10 years (Σ n=2,013 individuals).

- Demographic population structure derived from gillnet catches by accounting for the size-selectivity of the fishing gear for survival calculations.
- Assembling of four differently structured and dimensioned PPMs in RAMAS® Metapop.
- Comparison of modeling results (population growth, elasticities)
- Comparison of model trajectories with lake fish biomass (hydro acoustic) and gillnet CPUE development.

Demographic structure

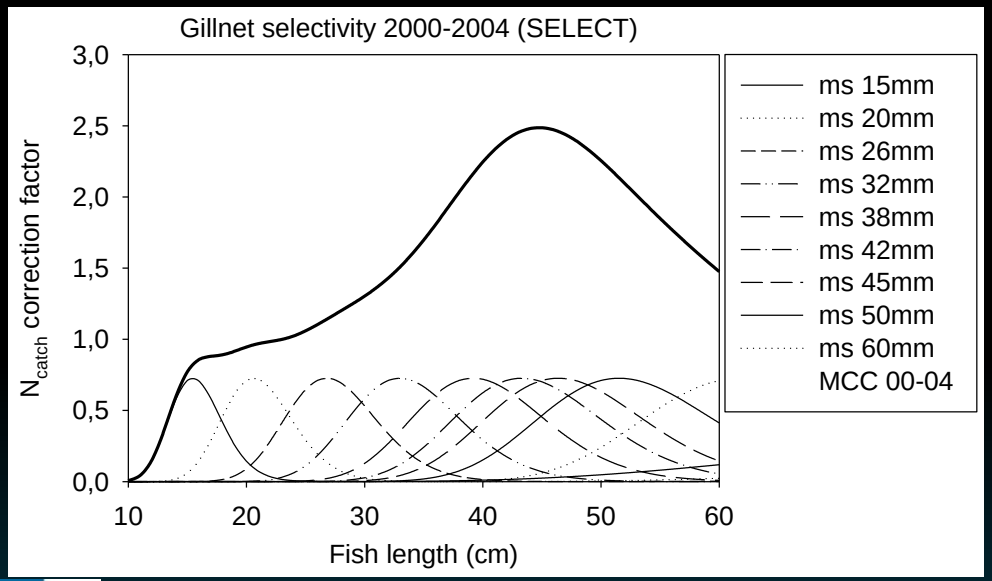
Length- and age-frequency distribution of the population derived from gillnet catches corrected by the selectivity of mesh sizes.

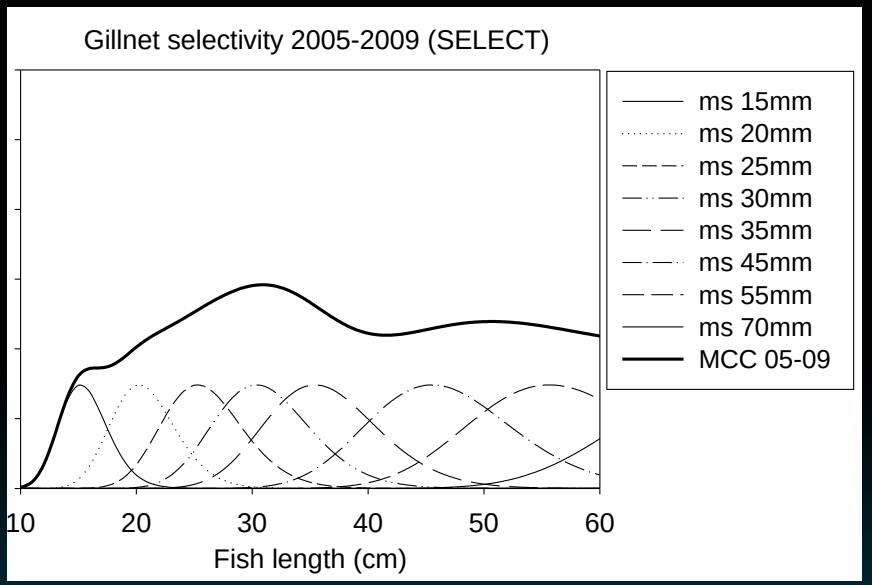
SELECT[1]-method = calculation of selectivity of gillnets on fish size

[1] developed by: Millar & Holst (1997), Millar & Freyer (1999), Millar (2000), Millar (2010)

- maximum likelihood based

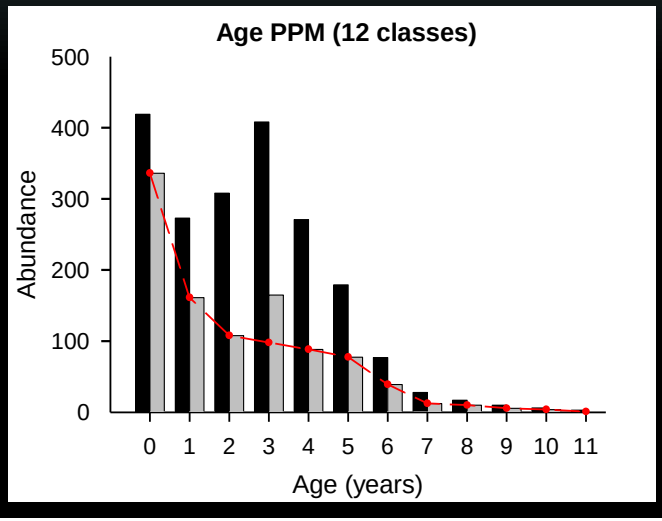
  (normal scale, normal spread, lognormal, bi-normal and bi-lognormal)

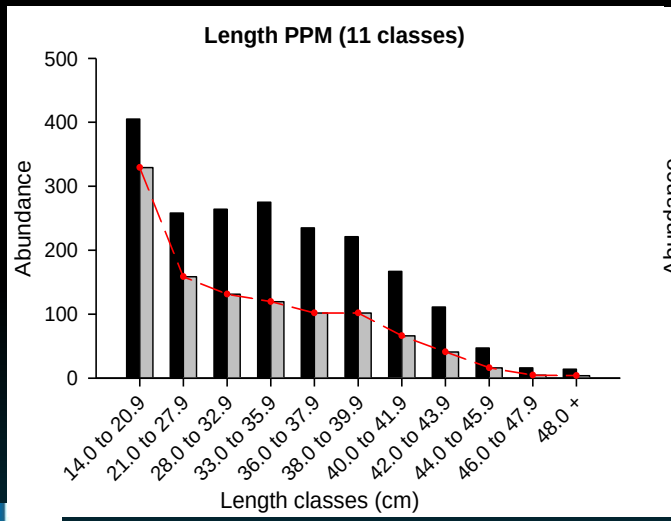


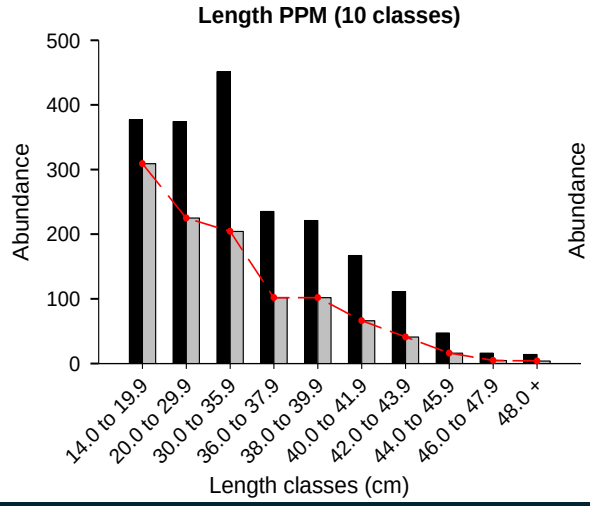


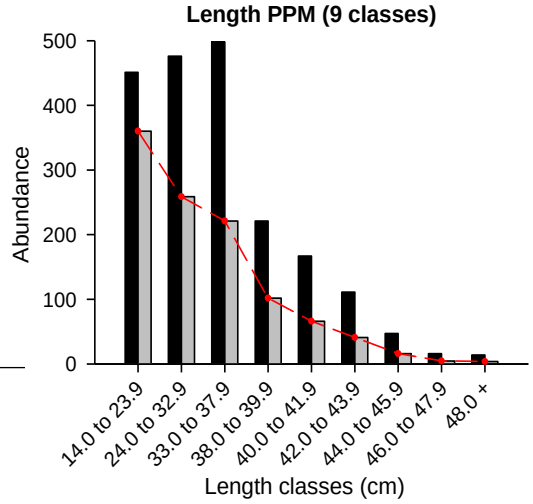
Demographic structure + Survival

Gillnet catch
SELECT corrected
Survival between classes

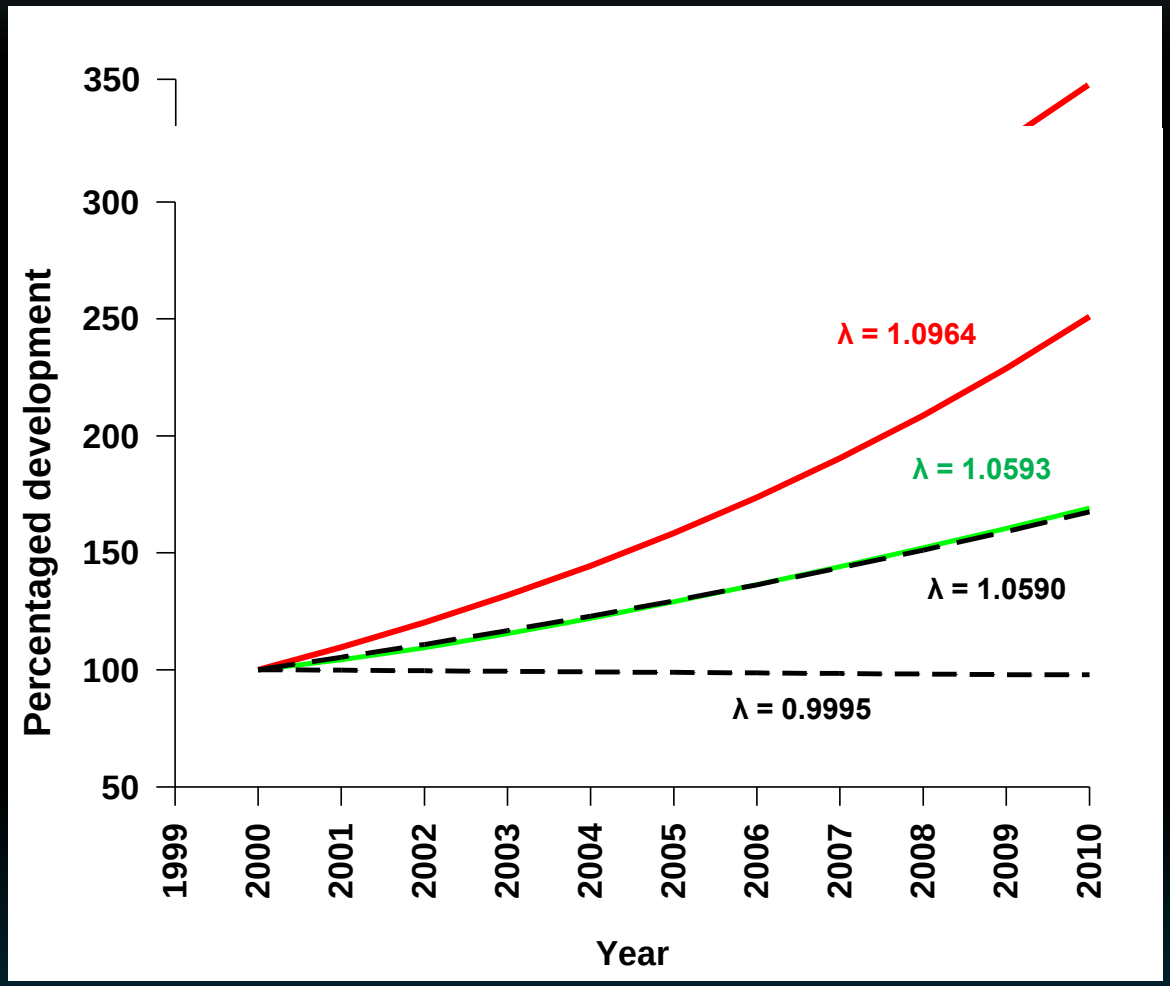








PPMs results



Age PPM (12 classes)
Length PPM (11 classes)
Length PPM (10 classes)
Length PPM (9 classes)

Observed distribution of the year 2000

↓

Exponential growth

Scramble density dependence

↓

Growth with transient dynamics

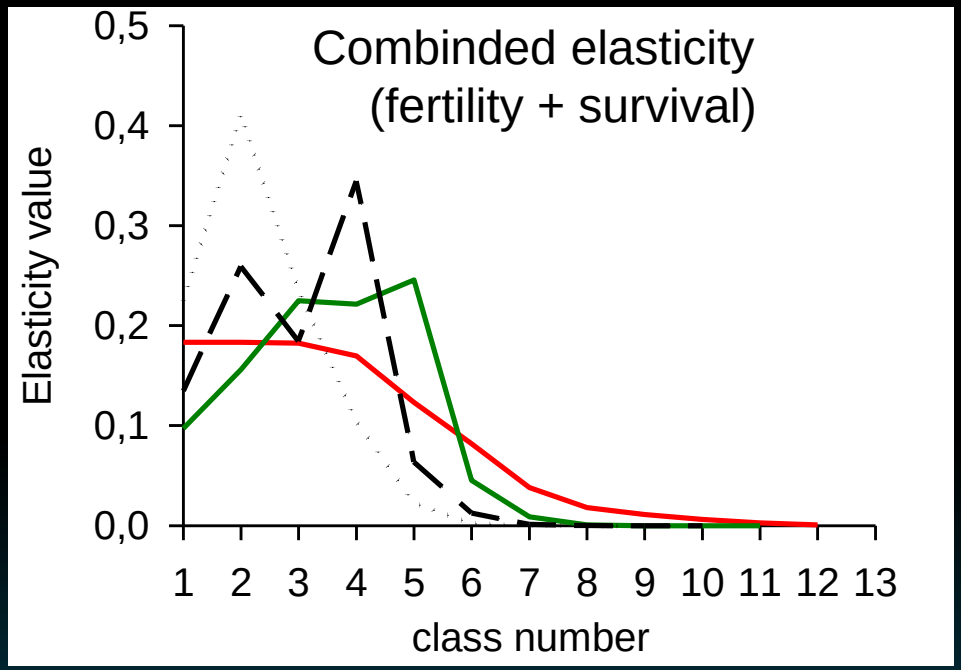
↓

Damped growth with transient dynamics

PPMs parameter importance for λ: Elasticity

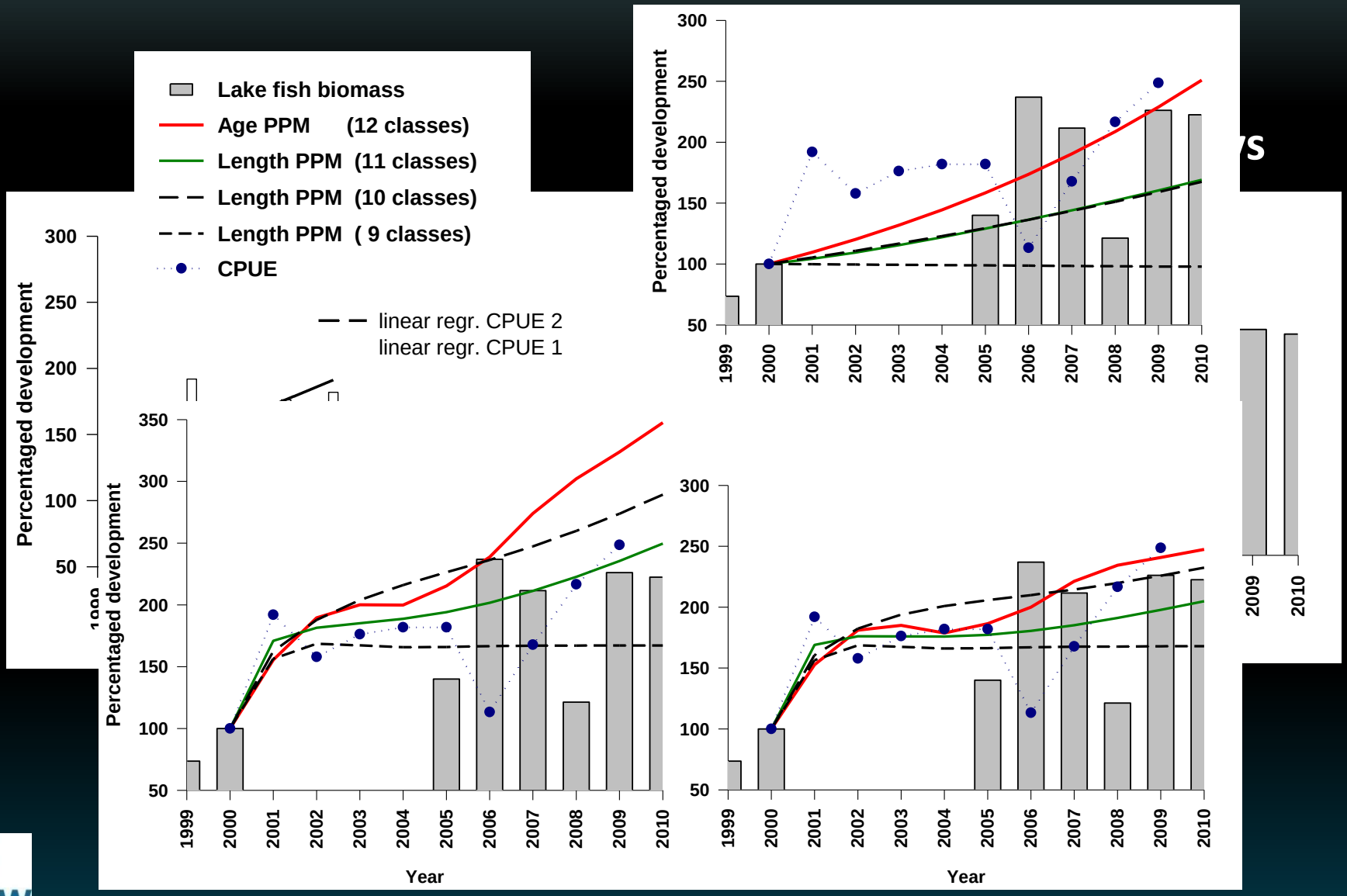
Perturbation analysis = PPMs parameter contribution to population growth (λ)

Elasticity = Proportional contribution of PPM parameters to proportional changes in λ



Age PPM (12 classes)
Length PPM (11 classes)
Length PPM (10 classes)
Length PPM (9 classes)

PPMs verification



Take Home Message

- Size-selectivity should definitely be considered when using gillnet catches for the calculation of vital rates.
- PPMs for whitefish populations can be constructed on age and length data and give comprehensive results for the population development.
- The magnitude of the contribution of matrix parameters to λ causes differences in modeling results of age and length based PPMs.
- Observed model differences suggest that multiple models should be used for the incorporation of environmental and ecological effects.

Thank you for your attention !