This project has been funded by the Eurpean Maritime and Fisheries Fund and the Danish Fisheries Agency

Advancing assessment methods for data-limited fish stocks

T.K. Mildenberger[1], C.W. Berg[1],
A. Kokkalis[1], M.W. Pedersen[2], J.R. Nielsen[1]

[1] *National Institute of Aquatic Resources, Kemitorvet, 2800 Kgs. Lyngby, Denmark*
[2] *ENFOR A/S, LyngsøAllé 3, 2970 Hørsholm, Denmark*

Seattle, July 2018

Contact: tobm@aqua.dtu.dk

IIFET 2018 SEATTLE

DTU Aqua
National Institute of Aquatic Resources

Stock categories according to ICES (2012)

Cat 1: Data-rich stocks (quantitative assessments)

Cat 2: Stocks with analytical assessments and forecasts that are only treated qualitatively

Cat 3: Stocks for which survey-based assessments indicate trends

Cat 4: Stocks for which reliable catch are available

Cat 5: Data-poor stocks

Cat 6: Negligible landings stocks and stocks caught in minor amounts as bycatch

ICES, 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. In: ICES CM 2012/ACOM 68, p. 42.

Stock categories according to ICES (2012)

Cat 1: Data-rich stocks (quantitative assessments)

Cat 2: Stocks with analytical assessments and forecasts that are only treated qualitatively

Cat 3: Stocks for which survey-based assessments indicate trends

Cat 4: Stocks for which reliable catch are available

Cat 5: Data-poor stocks

Cat 6: Negligible landings stocks and stocks caught in minor amounts as bycatch

Data-limited

ICES, 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. In: ICES CM 2012/ACOM 68, p. 42.

TropFishR

Tropical Fisheries analysis in R

Methods in Ecology and Evolution

BRITISH ECOLOGICAL SOCIETY

Methods in Ecology and Evolution 2017 doi: 10.1111/2041-210X.12791

APPLICATION

`TropFishR`: an `R` package for fisheries analysis with length-frequency data

Tobias Karl Mildenberger*[,1], Marc Hollis Taylor[2] and Matthias Wolff[3]

[1]National Institute of Aquatic Resources, Technical University of Denmark, Kemitorvet, Building 202, 2800 Kgs. Lyngby, Denmark; [2]Johann Heinrich von Thünen Institute, Palmaille 9, 22767 Hamburg-Altona, Germany; and [3]Leibniz Centre for Tropical Marine Research (ZMT), Fahrenheitstr. 6, 28359 Bremen, Germany

Tropical Fisheries analysis in R

Methods in Ecology and Evolution

Methods in Ecology and Evolution 2017 doi: 10.1111/2041-210X.12791

APPLICATION

TropFishR: an R package for fisheries analysis with length-frequency data

Tobias Karl Mildenberger*[,1], Marc Hollis Taylor[2] and

[1]*National Institute of Aquatic Resources, Technical University of Denn Denmark;* [2]*Johann Heinrich von Thünen Institute, Palmaille 9, 22767 I Tropical Marine Research (ZMT), Fahrenheitstr. 6, 28359 Bremen, Ge*

DOI: 10.1111/fme.12232

ORIGINAL ARTICLE

WILEY Fisheries Management and Ecology

Extending electronic length frequency analysis in R

M. H. Taylor[1] | T. K. Mildenberger[2]

[1]Thünen Institute of Sea Fisheries, Hamburg, Germany

[2]DTU AQUA - National Institute of Aquatic Resources, Technical University of Denmark, Kongens Lyngby, Denmark

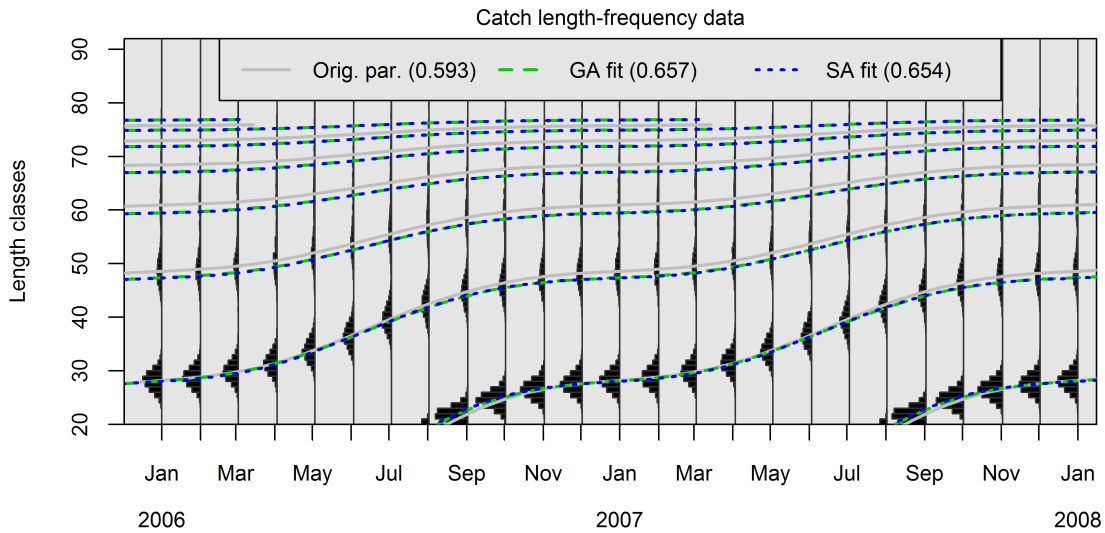
Correspondence
Marc H. Taylor, Thünen Institute of Sea Fisheries, Hamburg, Germany.
Email: marc.taylor@thuenen.de

Abstract

Electronic length frequency analysis (ELEFAN) is a system of stock assessment methods using length-frequency (LFQ) data. One step is the estimation of growth from the progression of LFQ modes through time using the von Bertalanffy growth function (VBGF). The option to fit a seasonally oscillating VBGF (soVBGF) requires a more intensive search due to two additional parameters. This work describes the implementation of two optimisation approaches ("simulated annealing" and "genetic algorithm")

DTU Aqua
National Institute of Aquatic Resources

Electronic length frequency analysis 2.0

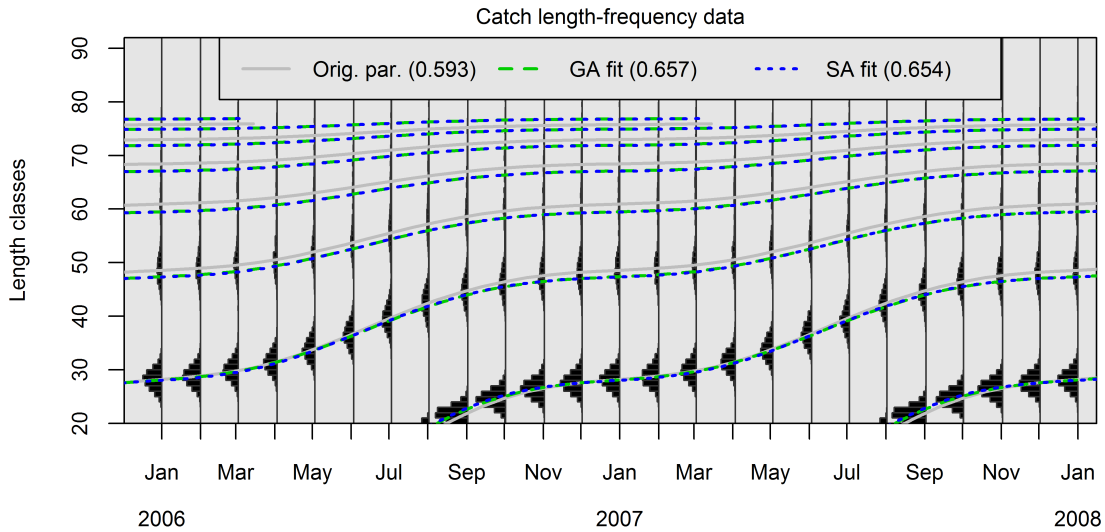


Taylor & Mildenberger (2017)

DTU Aqua
National Institute of Aquatic Resources

Electronic length frequency analysis 2.0

→ Flexible restructuring

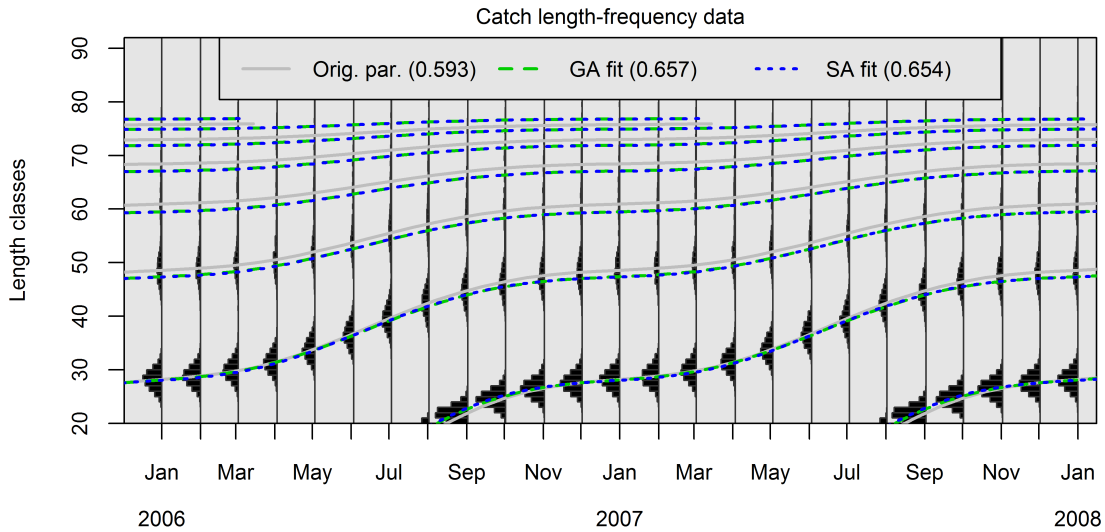


Taylor & Mildenberger (2017)

Electronic length frequency analysis 2.0

→ Flexible restructuring

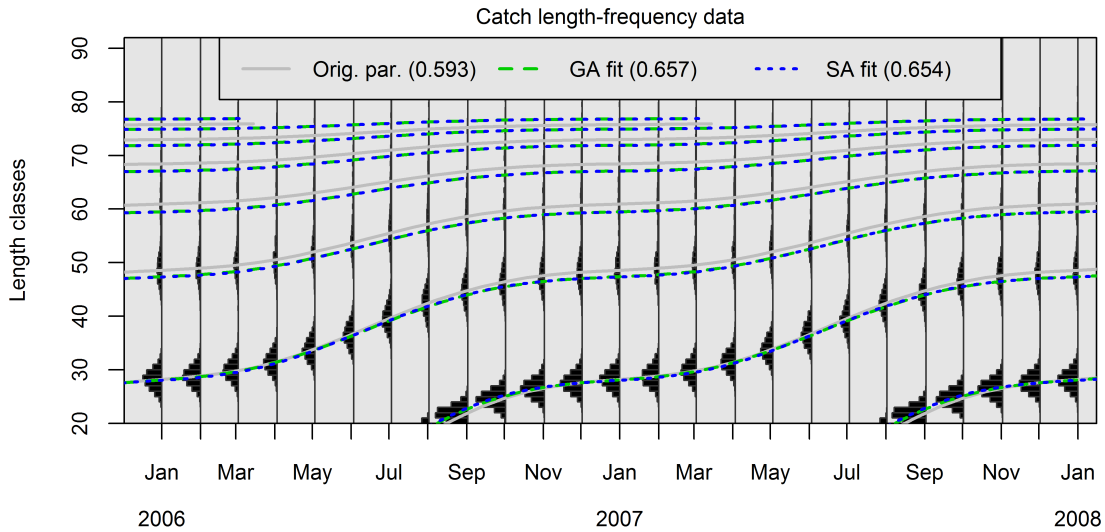
→ Fast and objective optimisation



Taylor & Mildenberger (2017)

Electronic length frequency analysis 2.0

- → Flexible restructuring
- → Fast and objective optimisation
- → Seasonalised von Bertalanffy function



Taylor & Mildenberger (2017)

DTU Aqua
National Institute of Aquatic Resources

Bootstrap fish stock assessment

FAO (1998); Mildenberger et al. (2017), Mildenberger et al. (in prep)

Bootstrap fish stock assessment

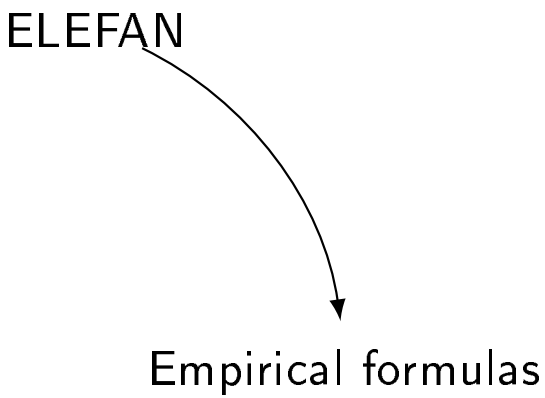
ELEFAN

$\rightarrow$ Linf, K, t_{anchor}

FAO (1998); Mildenberger et al. (2017), Mildenberger et al. (in prep)

DTU Aqua
National Institute of Aquatic Resources

Bootstrap fish stock assessment

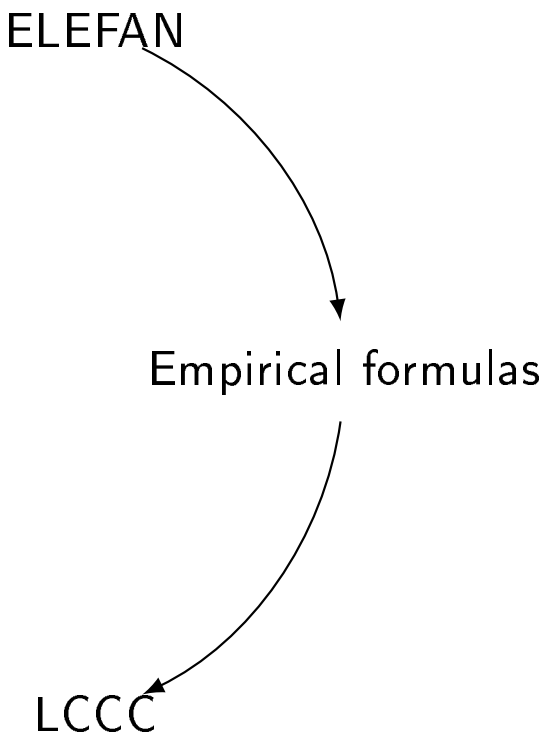


→ Linf, K, t_{anchor}

→ M

FAO (1998); Mildenberger et al. (2017), Mildenberger et al. (in prep)

Bootstrap fish stock assessment



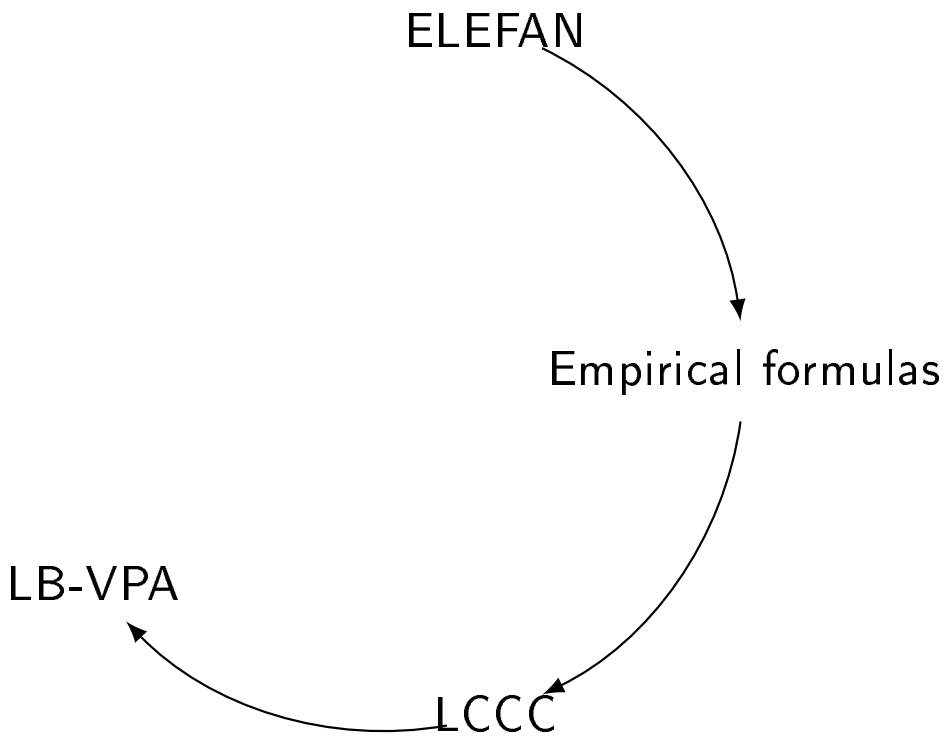
→ Linf, K, t_{anchor}

→ M

→ Z, F

FAO (1998); Mildenberger et al. (2017), Mildenberger et al. (in prep)

Bootstrap fish stock assessment



→ Linf, K, t_{anchor}

→ M

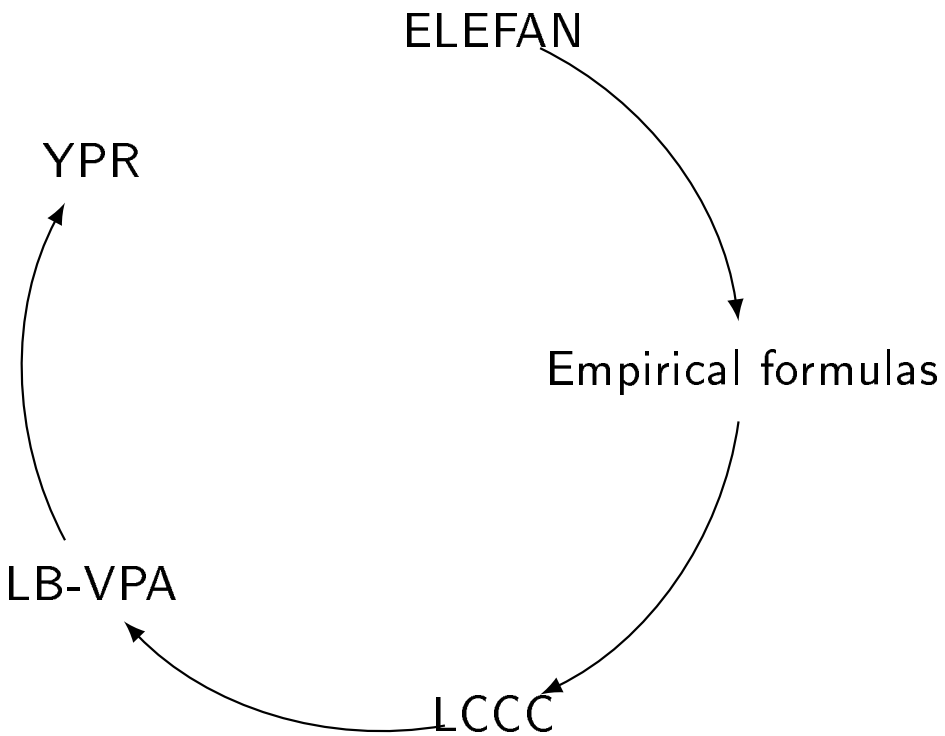
→ Z, F

→ F per length class

FAO (1998); Mildenberger et al. (2017), Mildenberger et al. (in prep)

DTU Aqua
National Institute of Aquatic Resources

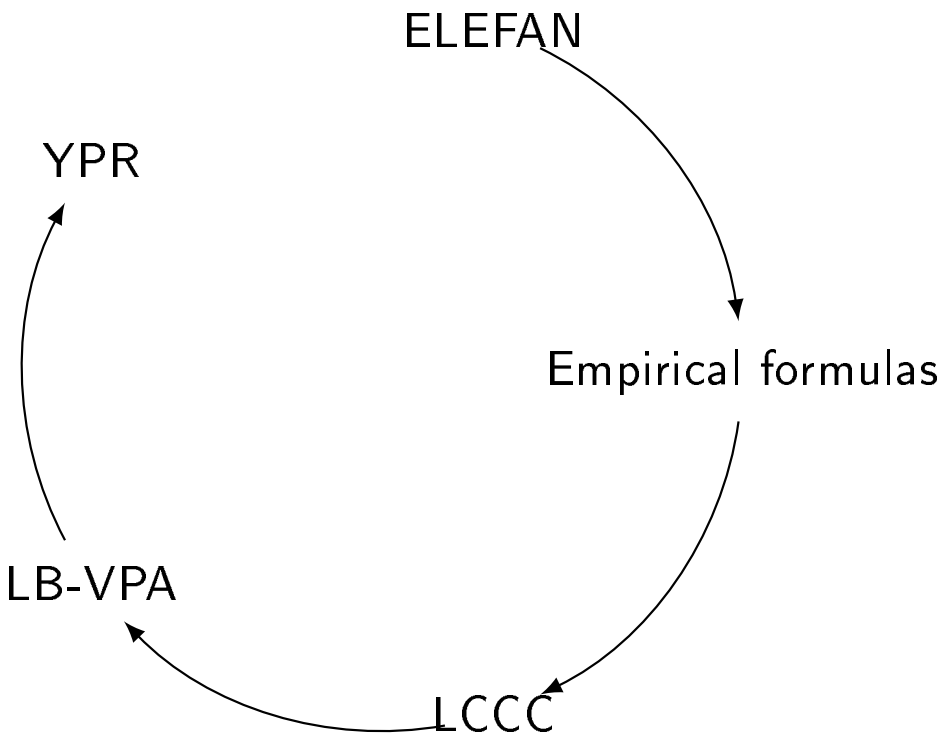
Bootstrap fish stock assessment



- → Linf, K, t_{anchor}
- → M
- → Z, F
- → F per length class
- → F_{01}, F/F_{01}

FAO (1998); Mildenberger et al. (2017), Mildenberger et al. (in prep)

Bootstrap fish stock assessment



500-1000

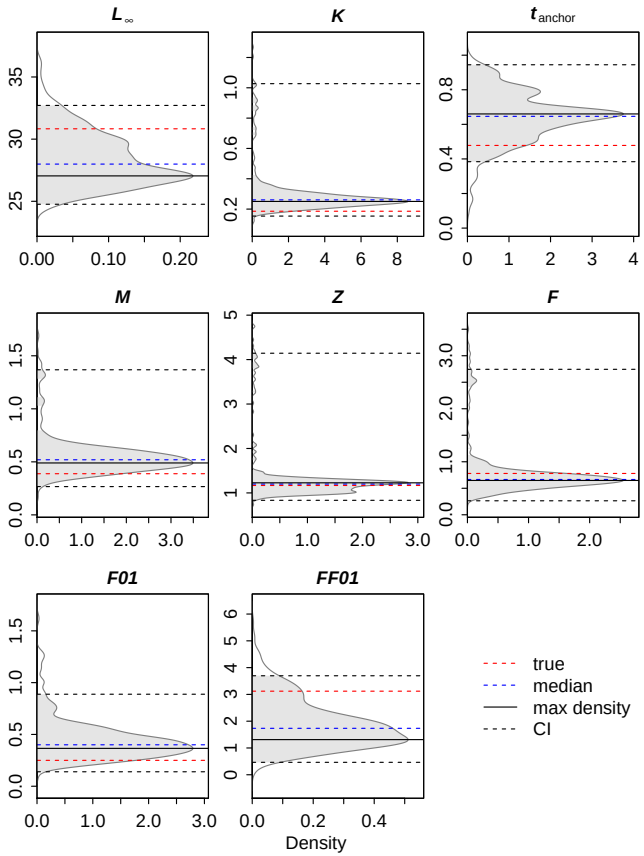
- → Linf, K, t_{anchor}
- → M
- → Z, F
- → F per length class
- → F_{01}, F/F_{01}

FAO (1998); Mildenberger et al. (2017), Mildenberger et al. (in prep)

DTU Aqua
National Institute of Aquatic Resources

Bootstrap fish stock assessment

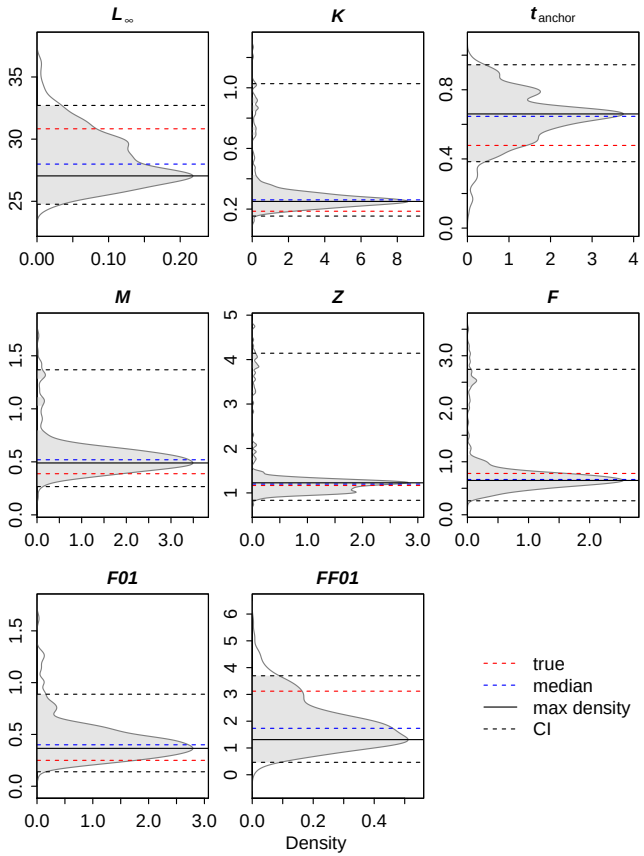
500 resamples



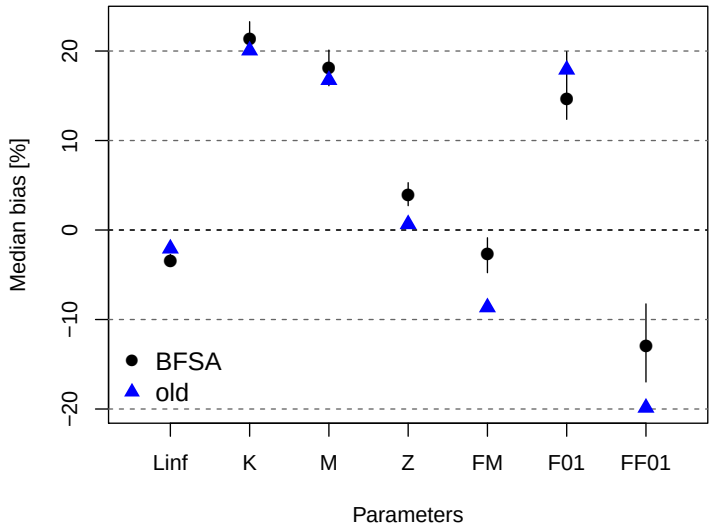
Schwamborn et al. (submitted); Mildenberger et al. (in prep)

Bootstrap fish stock assessment

500 resamples



300 simulations



Schwamborn et al. (submitted); Mildenberger et al. (in prep)

SPiCT

FISH and FISHERIES

A stochastic surplus production model in continuous time

Martin W Pedersen & Casper W Berg

National Institute of Aquatic Resources, Technical University of Denmark, Charlottenlund Slot, Jægersborg Allé 1, 2920 Copenhagen, Denmark

Pedersen & Berg (2016)

DTU Aqua
National Institute of Aquatic Resources

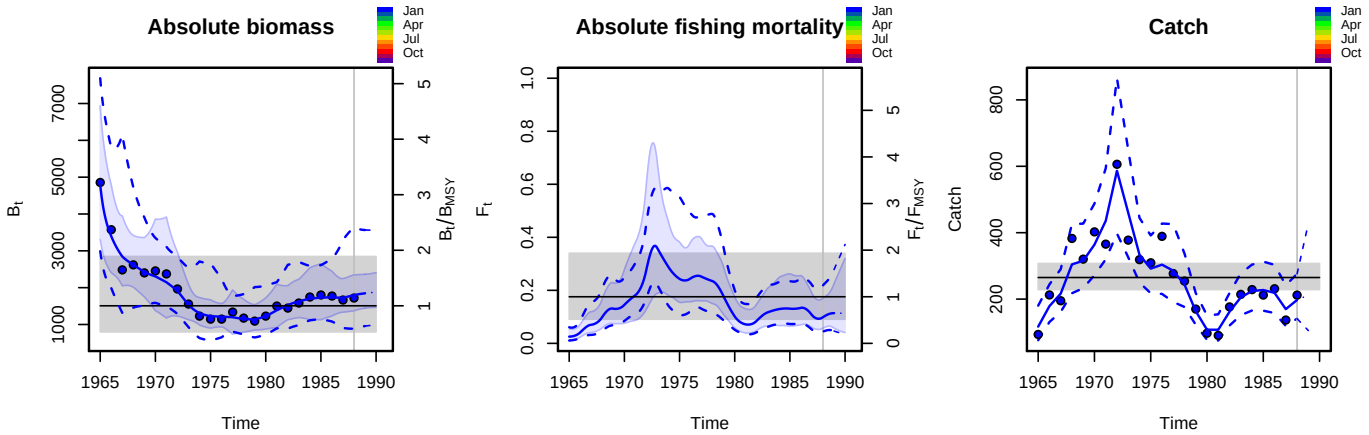
SPiCT

FISH and FISHERIES

A stochastic surplus production model in continuous time

Martin W Pedersen & Casper W Bera

National Institute of Aquatic Resources
Copenhagen, Denmark



Pedersen & Berg (2016)

Stochastic production model in continuous time (SPiCT)

Biomass process

$$dB_t = \left(\gamma m \frac{B_t}{K} - \gamma m \left[\frac{B_t}{K}\right]^n - F_t B_t\right) dt + \sigma_B B_t dW_t$$

Fishing mortality process

$$d\log(F_t) = f(t, \sigma_F)$$

Index observations

$$I_t = qB_t \cdot e^{\nu_t}$$

Catch observations

$$C_t = \int_t^{t+\Delta} F_s B_s ds \cdot e^{\varepsilon_t}$$

B_t: Exploitable stock biomass

F_t: Fishing mortality

K: Carrying capacity

n: Shape of production curve

m: Productivity parameter

q: Catchability

σ_B, σ_F, σ_I, σ_C: noise terms

W_t: Brownian motion

$\nu_t \sim N(0, \sigma_I^2)$ and $\varepsilon_t \sim N(0, \sigma_C^2)$

Pedersen & Berg (2016)

Stochastic production model in continuous time (SPiCT)

Biomass process

$$dB_t = \left(\gamma m \frac{B_t}{K} - \gamma m \left[\frac{B_t}{K}\right]^n - F_t B_t\right) dt + \sigma_B B_t dW_t$$

Fishing mortality process

$$d\log(F_t) = f(t, \sigma_F)$$

Index observations

$$I_t = qB_t \cdot e^{\nu_t}$$

Catch observations

$$C_t = \int_t^{t+\Delta} F_s B_s ds \cdot e^{\varepsilon_t}$$

B_t: Exploitable stock biomass

F_t: Fishing mortality

K: Carrying capacity

n: Shape of production curve

m: Productivity parameter

q: Catchability

σ_B, σ_F, σ_I, σ_C: noise terms

W_t: Brownian motion

$\nu_t \sim N(0, \sigma_I^2)$ and $\varepsilon_t \sim N(0, \sigma_C^2)$

Pedersen & Berg (2016)

Stochastic production model in continuous time (SPiCT)

Biomass process

$$dB_t = \left(\gamma m \frac{B_t}{K} - \gamma m \left[\frac{B_t}{K}\right]^n - F_t B_t\right) dt + \sigma_B B_t dW_t$$

Fishing mortality process

$$d\log(F_t) = f(t, \sigma_F)$$

Index observations

$$I_t = qB_t \cdot e^{\nu_t}$$

Catch observations

$$C_t = \int_t^{t+\Delta} F_s B_s ds \cdot e^{\varepsilon_t}$$

B_t: Exploitable stock biomass

F_t: Fishing mortality

K: Carrying capacity

n: Shape of production curve

m: Productivity parameter

q: Catchability

σ_B, σ_F, σ_I, σ_C: noise terms

W_t: Brownian motion

$\nu_t \sim N(0, \sigma_I^2)$ and $\varepsilon_t \sim N(0, \sigma_C^2)$

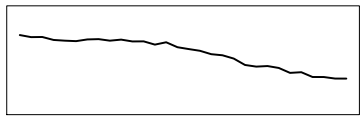
Pedersen & Berg (2016)

Time-varying productivity

$$dB_t = \left(\gamma m_t \frac{B_t}{K} - \gamma m_t \left[\frac{B_t}{K}\right]^n - F_t B_t\right) dt + \sigma_B B_t dW_t$$

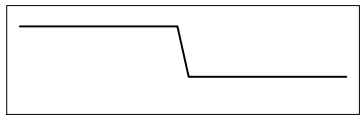
1: Gradual model

$$m_t = m_{base} \cdot \kappa m_t$$



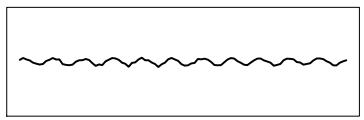
2: Regime shift model

$$m_t = m_{base} \cdot \Delta m_{k(t)}$$



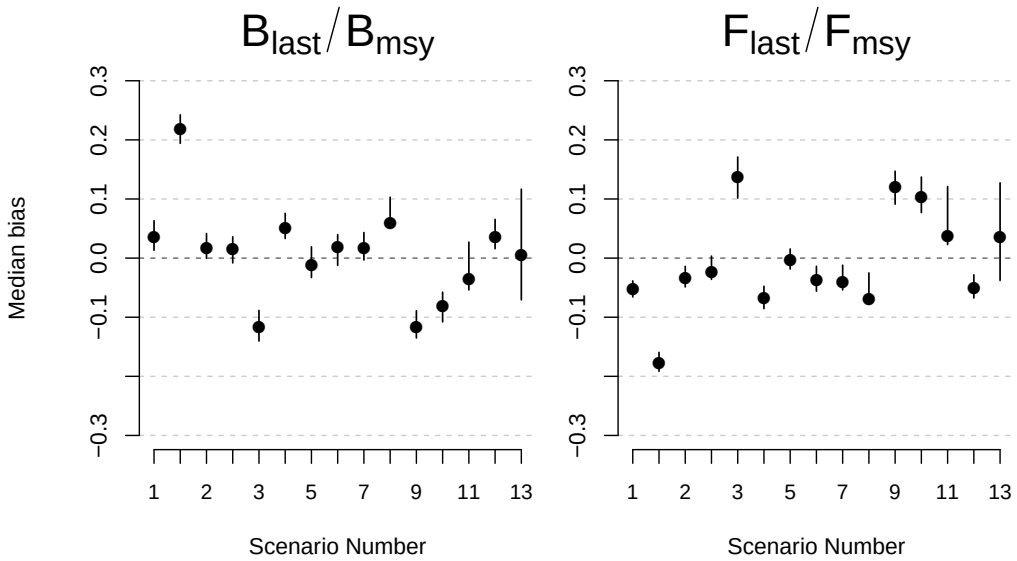
3: Seasonal model

$$m_t = m_{base} \cdot \xi_{l(t)}$$



Mildenberger et al. (in prep)

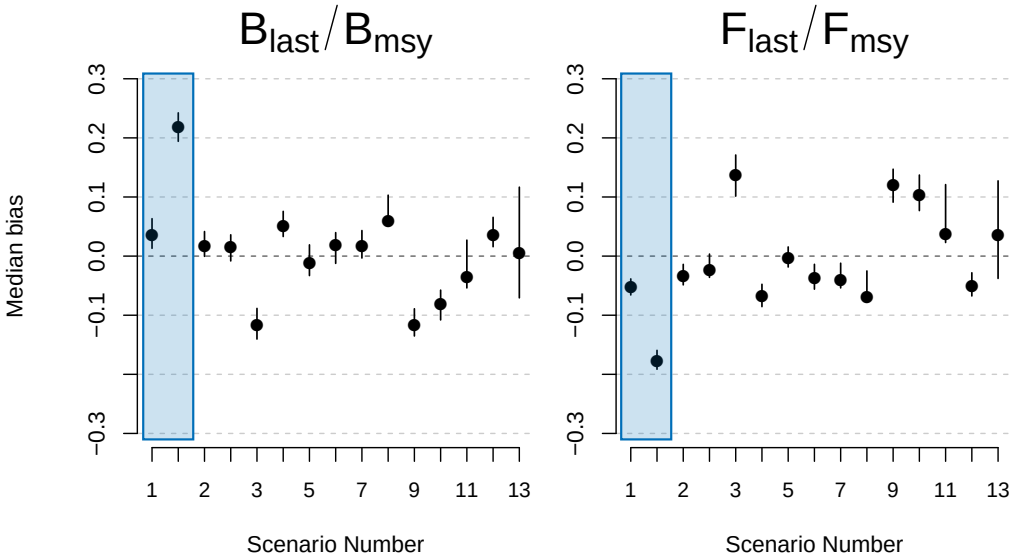
Time-varying productivity



Mildenberger et al. (in prep)

DTU Aqua
National Institute of Aquatic Resources

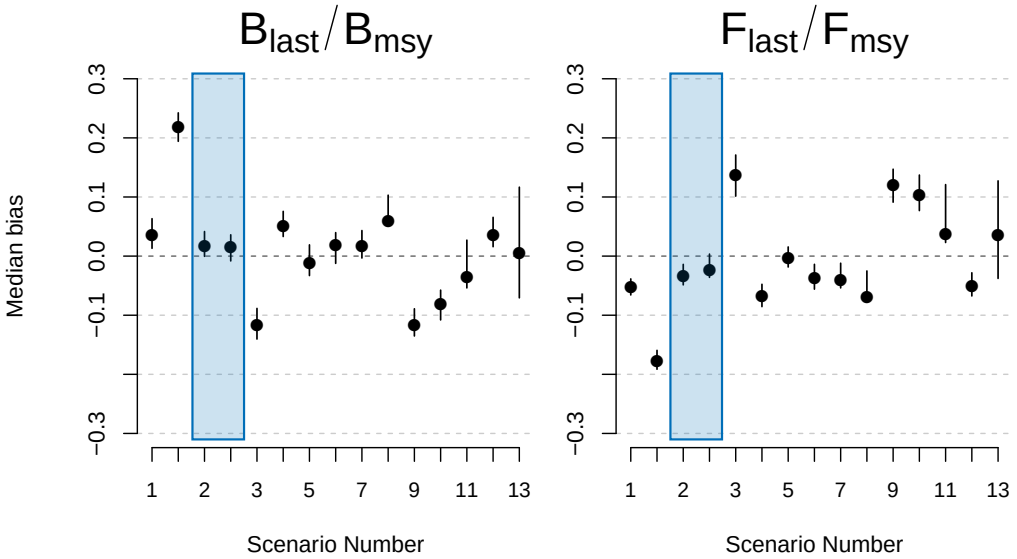
Time-varying productivity



→ Seasonal model more conservative

Mildenberger et al. (in prep)

Time-varying productivity

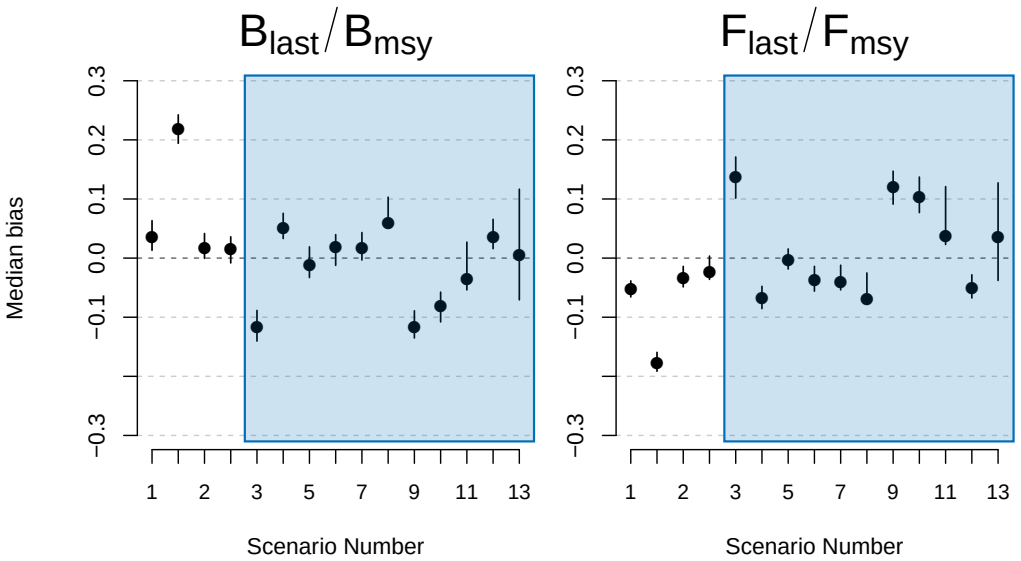


→ Seasonal model more conservative

→ No disadvantage

Mildenberger et al. (in prep)

Time-varying productivity



→ Seasonal model more conservative

→ No disadvantage

→ Two or more biomass indices per year required

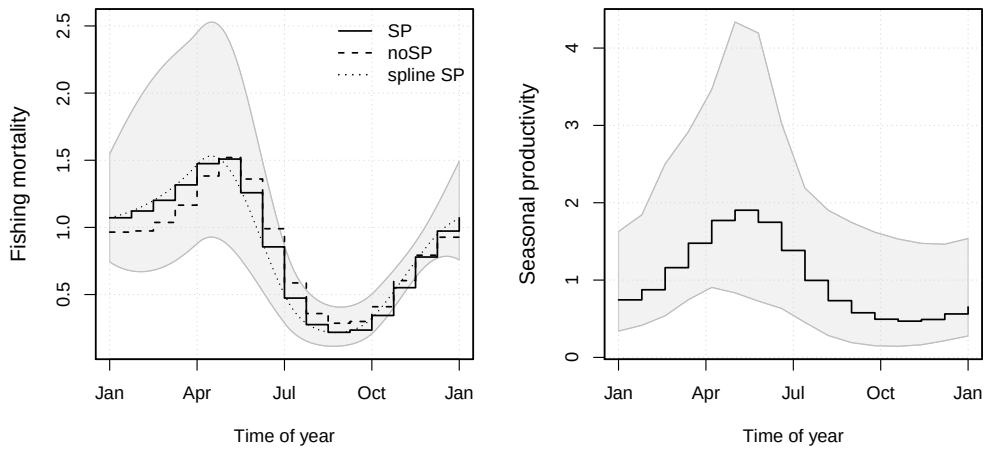
Mildenberger et al. (in prep)

Time-varying productivity

Mildenberger et al. (in prep)

Time-varying productivity

- ✓ Seasonal productivity

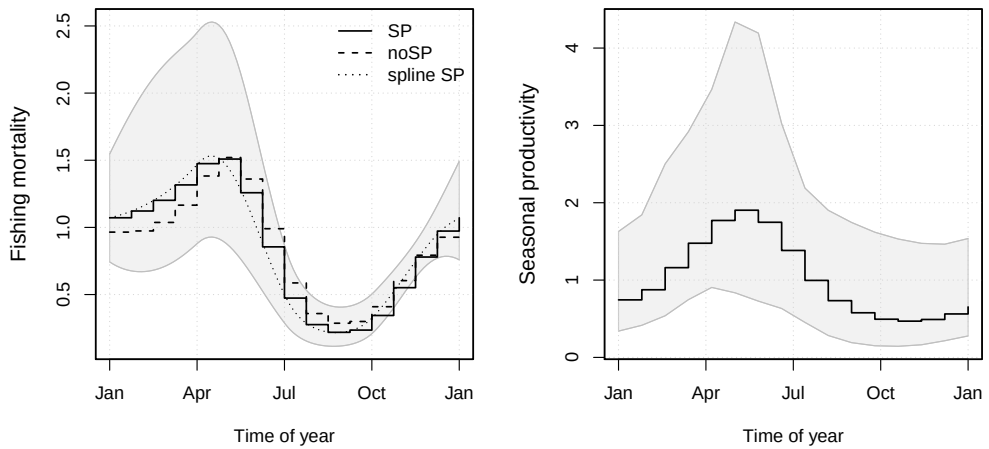


Mildenberger et al. (in prep)

DTU Aqua
National Institute of Aquatic Resources

Time-varying productivity

- ✓ Seasonal productivity
- ✓ Stock perception
- ✓ Temporal trends

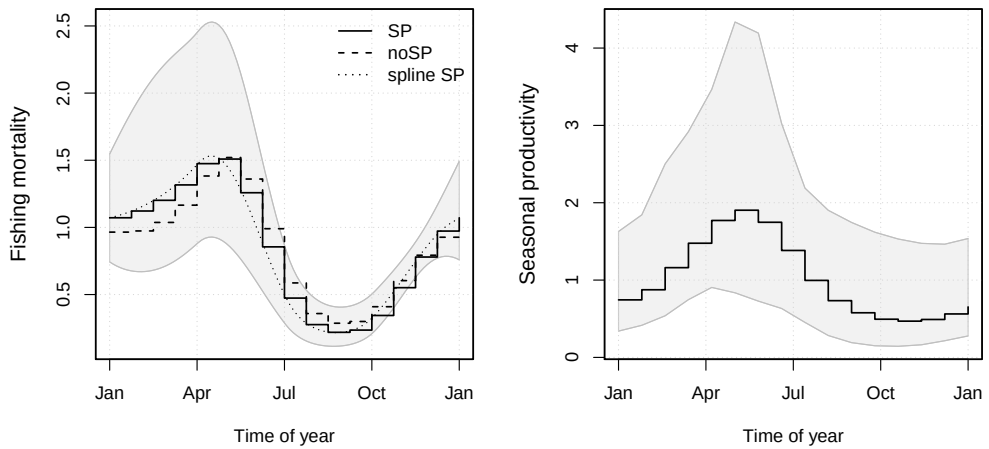


Mildenberger et al. (in prep)

DTU Aqua
National Institute of Aquatic Resources

Time-varying productivity

- ✓ Seasonal productivity
- ✓ Stock perception
- ✓ Temporal trends
- ✓ More conservative



Mildenberger et al. (in prep)

DTU Aqua
National Institute of Aquatic Resources

Stage-based SPiCT

Mildenberger et al. (in prep)

Stage-based SPiCT

$$dB_t = \left(\gamma m \frac{B_t}{K} - \gamma m \left[\frac{B_t}{K}\right]^n - F_t B_t\right) dt + \sigma_B B_t dW_t + \zeta J_t^n$$

ζ: Maturation parameter
J_t: Juvenile biomass

Mildenberger et al. (in prep)

DTU Aqua
National Institute of Aquatic Resources

Stage-based SPiCT

$$dB_t = \left(\gamma m \frac{B_t}{K} - \gamma m \left[\frac{B_t}{K}\right]^n - F_t B_t\right) dt + \sigma_B B_t dW_t + \zeta J_t^n$$

ζ: Maturation parameter
J_t: Juvenile biomass

- ★ States & reference levels in regard to SSB and ESB
- ★ Suitability for short-lived species
- ★ Better predictability

Mildenberger et al. (in prep)

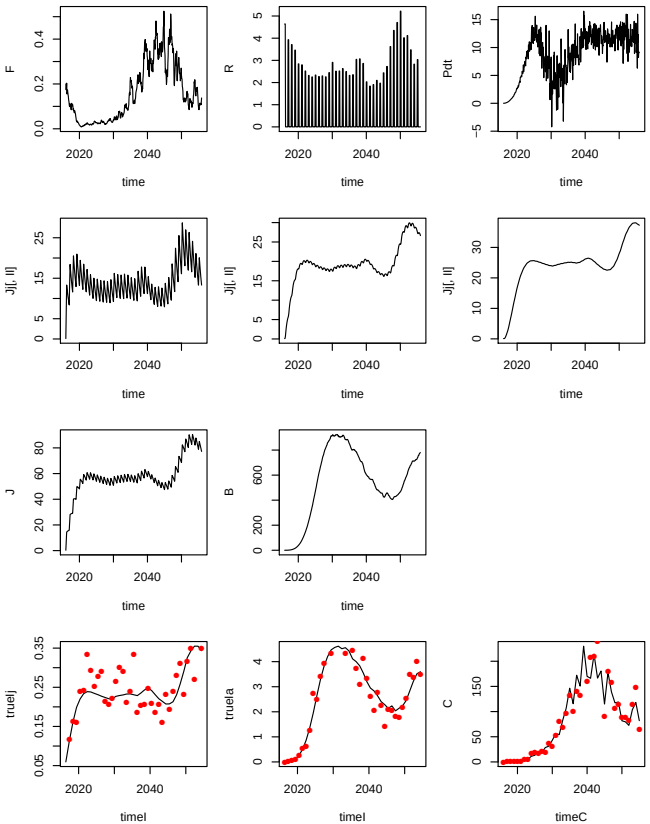
DTU Aqua
National Institute of Aquatic Resources

Stage-based SPiCT

$$dB_t = \left(\gamma m \frac{B_t}{K} - \gamma m \left[\frac{B_t}{K}\right]^n - F_t B_t\right) dt + \sigma_B B_t dW_t + \zeta J_t^n$$

ζ: Maturation parameter
J_t: Juvenile biomass

- ★ States & reference levels in regard to SSB and ESB
- ★ Suitability for short-lived species
- ★ Better predictability



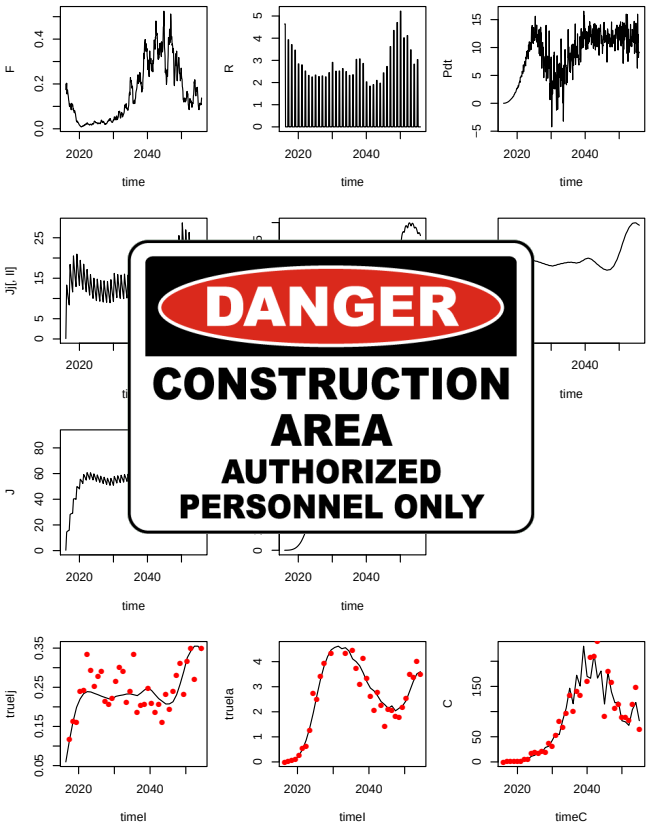
Mildenberger et al. (in prep)

Stage-based SPiCT

$$dB_t = \left(\gamma m \frac{B_t}{K} - \gamma m \left[\frac{B_t}{K}\right]^n - F_t B_t\right) dt + \sigma_B B_t dW_t + \zeta J_t^n$$

ζ: Maturation parameter
J_t: Juvenile biomass

- ★ States & reference levels in regard to SSB and ESB
- ★ Suitability for short-lived species
- ★ Better predictability



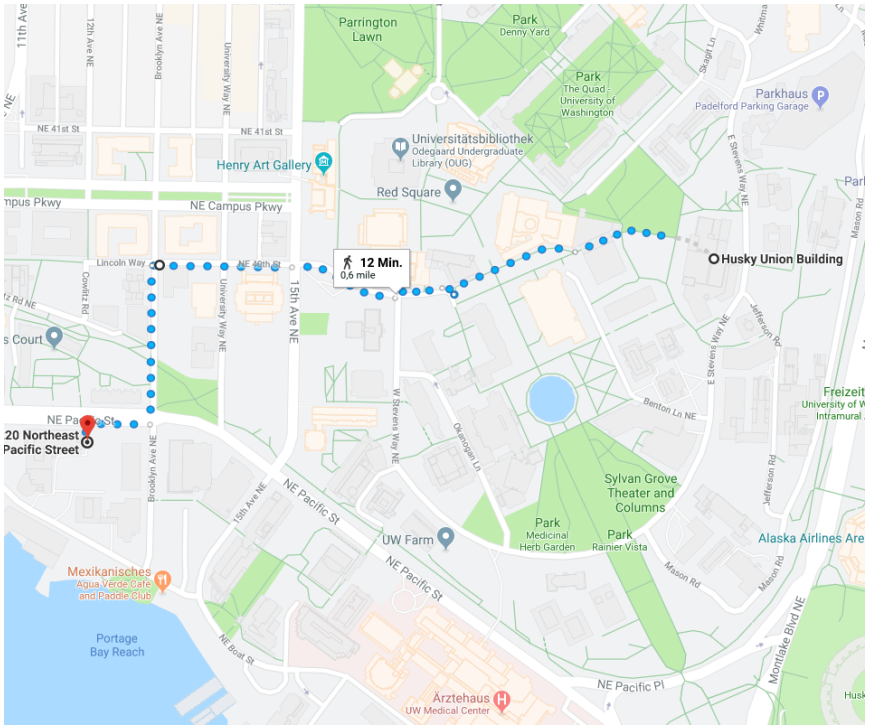
Mildenberger et al. (in prep)

Workshop:

Location: FSH 314

Time: 2pm - 5pm

→ tobm@aqua.dtu.dk



DTU Aqua
National Institute of Aquatic Resources