

Quantitative Methods in Fisheries Ecology and Open Science

Arni Magnusson
Data & Assmt Professional Officer
ICES Secretariat

Stony Brook University
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Science for sustainable seas

Outline



1. Background

- Fisheries ecology, population dynamics
- Statistical models, software development

2. Quantitative methods in fisheries ecology

- Selected studies: cod, shrimp, salmon, etc.
- Overview of basic ecological models

3. Open science

- ICES Methods Working Group
- Transparent Assessment Framework

1. Background

Arni Magnusson



Data & Assessment Professional Officer
ICES Secretariat, Copenhagen

Background

M.S. and Ph.D., University of Washington
Fish population dynamics Fisheries management
Statistical models Software development
National Fisheries Advisory Committee, Iceland

Software

AD Model Builder	Template Model Builder
glmmTMB	icesAdvice icesTAF

Lecturer

United Nations University Tech University Denmark	University of Iceland ICES Training Courses
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Stock Assessment Scientist



First author

- 2000–2016 Iceland: cod, silver smelt, herring, saithe
- 2001–2003 New Zealand: ling, blue whiting, smooth oreo
- 2012–2015 Greenland: inshore cod

Reviewer

- 2010– ICES: deep sea fishes, turbot, plaice, seabass, silver smelt
- 2011–2016 Iceland: National Advisory Committee, 37 stocks
- 2014 NOAA (CIE): Gulf of Mexico king mackerel
- 2016– Implementation of the ICES precautionary approach
- 2018 SPRFMO: Chilean jack mackerel
- 2019 NAFO: Newfoundland 3Ps cod

Other Services



Internal

- 2011–2015 Editor of annual report of assessments and advice for all Icelandic stocks
- 2013 Review of research proposals and funding priorities in Icelandic marine science
- 2014–2016 Creator and maintainer of <https://data.hafro.is>, open science repository
- 2017– Contact between ICES and the RAM Legacy Database

External

- 2009– Member of ADMB Foundation and Core Development Team
- 2017 Chair of stock assessment session at ICES Annual Science Conference
- 2017– Chair of the ICES Methods Working Group
- 2018– Member of SPRFMO Scientific Committee

Methods

What makes fisheries data informative for stock assessment (Magnusson and Hilborn 2007)

Performance of uncertainty methods in stock assessment (Magnusson et al. 2013)

Iceland

Population genetics of Icelandic cod (Jakobsdottir et al. 2011)

Influence of cod abundance and temperature on shrimp recruitment (Jonsdottir et al. 2013)

Remote sensing of chlorophyll in Icelandic waters (Gudmundsson et al. 2016)

Other regions

Estuarine influence on survival rates of Pacific salmon (Magnusson and Hilborn 2003)

State of the world's fisheries (Hilborn et al. 2003)

Population ecology of North Sea turbot and brill (van der Hammen et al. 2013)

Stock status of offshore shrimp stocks of Bangladesh (Barua et al. 2018)

Peer-reviewed publications

Core developer and coauthor of AD Model Builder (Fournier et al. 2012)

Coauthor of general guidelines for fitting nonlinear models (Bolker et al. 2013)

Paper on literate programming and reproducible analysis (Magnusson and Jonsson 2014)

Coauthor of high-impact R package glmmTMB (Brooks et al. 2017)

Other contributions

Significant contributions to base R since 2004 and TMB since 2013

First author of AD Studio, development environment for ADMB and TMB

Serve a key role in ICES Secretariat to assist all stock assessors with R coding

ICES training course instructor in ADMB and TMB model development

First author of 8 R packages on CRAN, including icesAdvice and icesTAF

2. Quantitative Methods in Fisheries Ecology

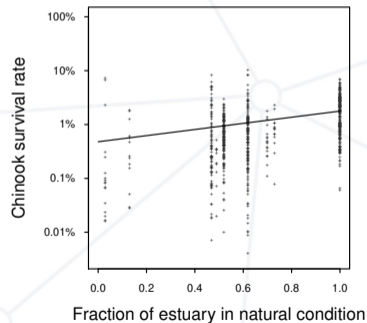
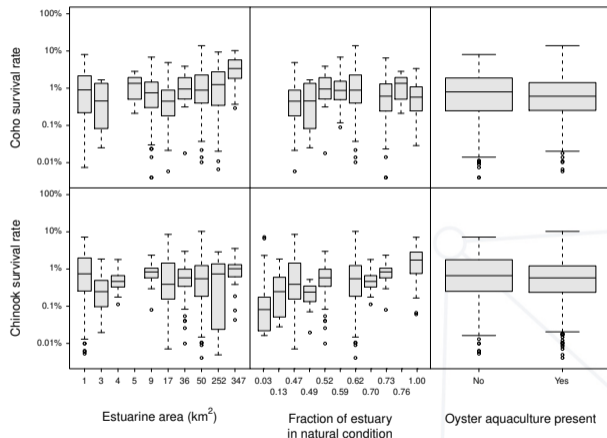
Selected Studies in Fisheries Ecology



1. Pacific salmon survival rates and estuaries (Magnusson & Hilborn 2003)
2. Shrimp recruitment (Jonsdottir et al. 2013)
3. Triploid cod in aquaculture (Derayat et al. 2013)
4. Chlorophyll remote sensing (Gudmundsson et al. 2016)
5. Shrimp in Bangladesh (Barua et al. 2018)

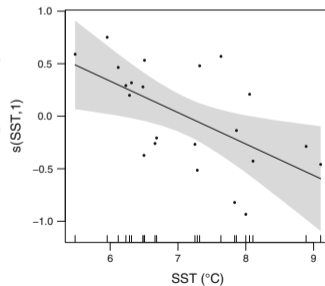
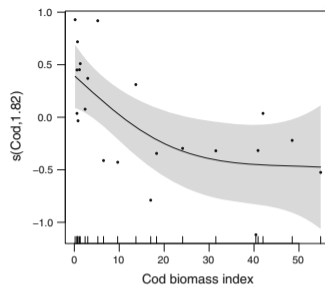
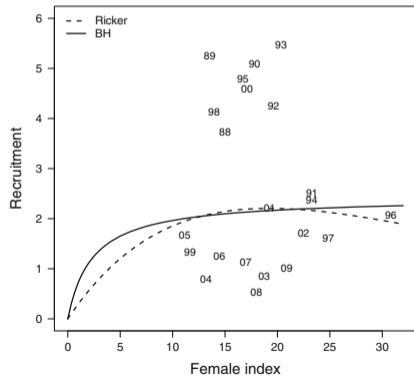
Pacific Salmon Survival Rates and Estuaries

Magnusson and Hilborn 2003



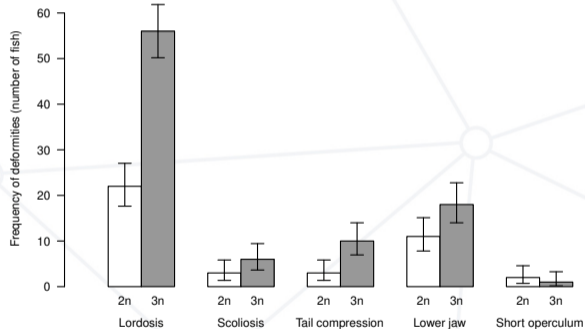
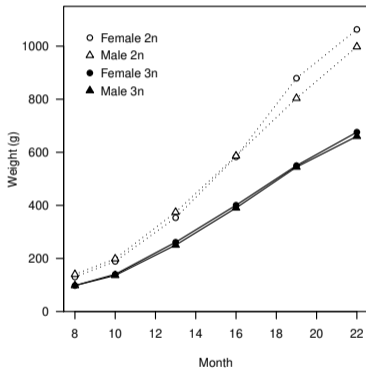
Shrimp Recruitment

Jonsdottir et al. 2013



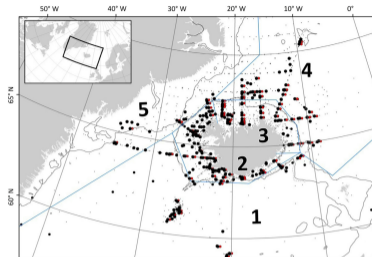
Triploid Cod in Aquaculture

Derayat et al. 2013



Chlorophyll Remote Sensing

Gudmundsson et al. 2016

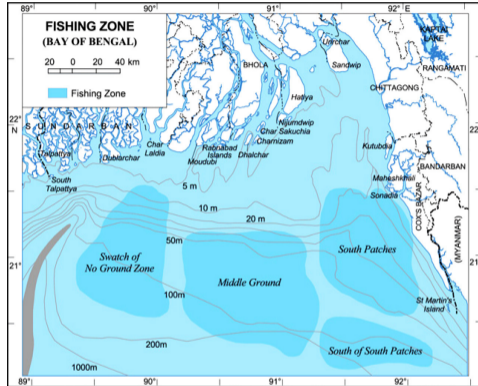


$$\widehat{\text{Chl } a} = \exp[0.166 + 0.740 \log(\text{CHL1}) + 0.0387 \text{Sun} - 0.00423 \text{Day} - 0.110 \log(\text{Depth})]$$

log(Chl <i>a</i>) vs.	Intercept	log(CHL1)	Sun	Day	log(Depth)	R ²	AIC
log(CHL1)	0.494	0.807				0.473	752.6
+ Sun	-1.226	0.764	0.0411			0.496	741.9
+ Day	-0.538	0.772	0.0402	-0.00413		0.510	735.8
+ log(Depth)	0.166	0.740	0.0387	-0.00423	-0.110	0.521	731.1
+ Bearing	0.250	0.741	0.0396	-0.00424	-0.120	0.522	732.6

Shrimp in Bangladesh

Barua et al. 2018



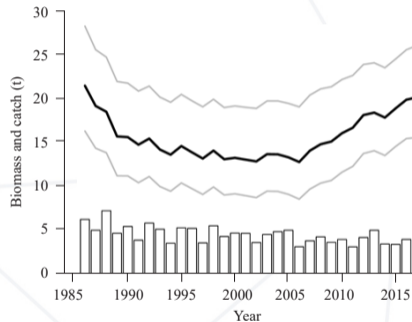
$$B_{t+1} = B_t + rB_t \left(1 - \frac{B_t}{K}\right) - C_t$$

Shrimp in Bangladesh

Barua et al. 2018



Quantity	Estimate	95% CI
r	0.597	0.426 - 0.837
K	31544	22605 - 44018
a	0.685	0.511 - 0.918
q	4.81×10^{-5}	$3.46 \times 10^{-5} - 6.68 \times 10^{-5}$
σ	0.124	0.097 - 0.159
u_{2016}	0.204	0.159 - 0.263
B_{2017}	20286	15706 - 26201
u_{MSY}	0.298	0.213 - 0.418
B_{MSY}	15772	11302 - 22009
MSY	4709	4565 - 4858



The ICES Methods Working Group focuses on **stock assessment methods**.

The objectives of the Methods WG are to improve existing assessment models and develop new ones, organize a collection of datasets, test the performance of new and existing models, and work on assessment-related techniques.

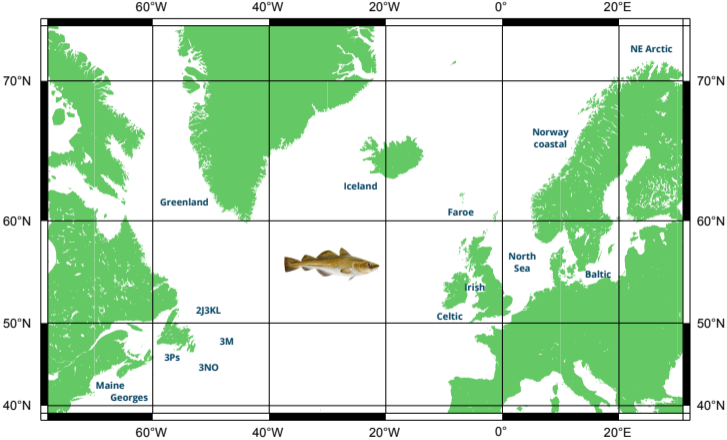
Methods WG on GitHub



The screenshot shows the GitHub repository page for 'ices-eg / wg_MGWG'. The browser address bar shows the URL 'https://github.com/ices-eg/wg_MGWG'. The repository name is 'ices-eg / wg_MGWG' with 41 stars, 5 unstars, and 9 forks. The repository is owned by 'ICES Methods Working Group'. It has 1,039 commits, 1 branch, 5 releases, and 26 contributors. The current branch is 'master'. The repository contains several folders, each with a description and a commit date:

Folder Name	Description	Commit Date
2017-woods-hole	Thursday Dinner Directions	2 years ago
2018-Ispra	Add files via upload	last year
length-dist	Update README.md	2 hours ago
model-complexity	on hold until 2020	2 hours ago
selectivity	Initial manuscript, based on poster	20 hours ago
state-space	remove a mistakenly added file	32 minutes ago
stock-recruitment	Merge branch 'master' of github.com:ices-eg/wg_MGWG	28 days ago
time-varying	2 slides on time-varying	3 hours ago

Atlantic Cod Selectivity



3. Open Science

Open Science at ICES



Open Data

ICES databases can be accessed online, via **web services**

Open Source

Software maintained by the ICES Secretariat is hosted on

<https://github.com/ices-tools-prod>

icesAdvice, **icesDatras**, **icesTAF**, **icesVocab**

Open and Reproducible Research

ICES working groups make their analytical **scripts** available on

<https://github.com/ices-taf>

<https://github.com/ices-eg>

basis of advice

any other analyses

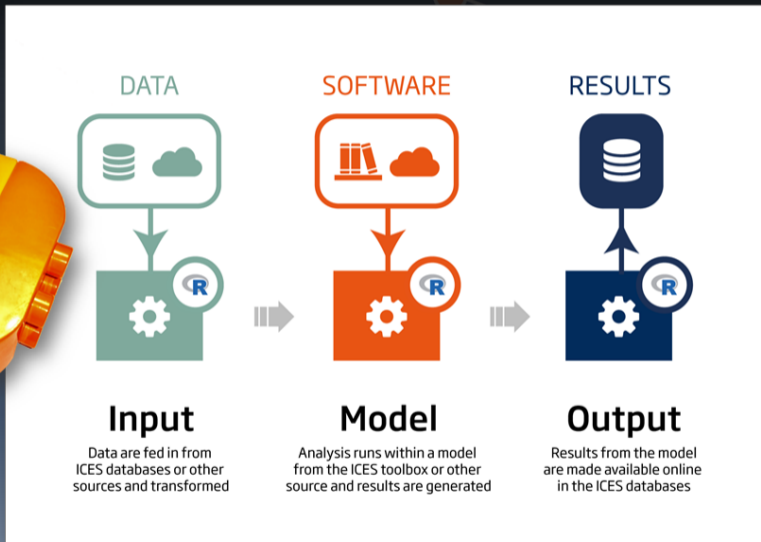
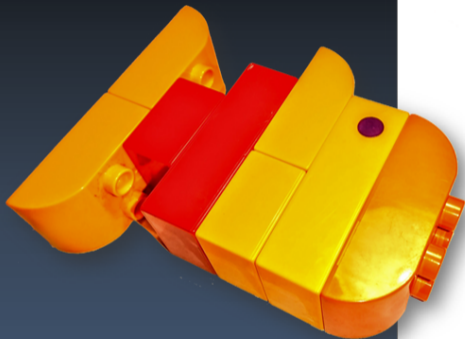
Transparent Assessment Framework (TAF)



Aim

Assure quality, improve efficiency, and ensure transparency of **data** and **analyses** used in the ICES advisory processes.

taf.ices.dk



Science for sustainable seas

TAF Overview



- ▶ ICES gives advice for over 200 stock assessments every year:
data preparation → analysis → peer review → advice
- ▶ Open: data files, model scripts, and results available **online**
- ▶ Reproducible: anyone can browse, download, and **run** the assessment, on their own computer or on the ICES TAF **server** (final run)
- ▶ Assessment repository is private, but the analysis becomes **public** after the peer review and advice is released
- ▶ Easy to see exactly **what has changed** in the data or model setup between years
- ▶ Standard sequence of scripts (data, model, output, report) facilitates **quality checks** and **peer review**

Summary



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