Report of the 1st working group meeting on optimization of fishing pressure in the Northeast Atlantic, Copenhagen June 2017

Project: Ecosystem Based FMSY Values in Fisheries Management

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NORDIC WORKING PAPERS

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Henrik Sparholt, Bjarte Bogstad, Villy Christensen, Jeremy Collie, Rob van Gemert, Ray Hilborn, Jan Horbowy, Daniel Howell, Michael C. Melnychuk, Søren Anker Pedersen, Claus Reedtz Sparrevohn, Gunnar Stefansson and Petur Steingrund

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Report of the 1st working group meeting on optimization of fishing pressure in the Northeast Atlantic, Copenhagen June 2017

Project: Ecosystem Based FMSY Values in Fisheries Management

A 2 year project funded by:

The European Maritime and Fisheries Fund & the Danish Ministry of Environment and Food (1.372 mio DKK), the Norwegian Fisheries Research Fund via IMR Norway (0.5 mio DKK) and from the Nordic Council of Ministers (0.5 mio DKK). The total budget for the project is therefore 3.057 mio DKK.

Meeting 20-21 June 2017,

Copenhagen, Denmark

Ministry of Environment and Food of Denmark

European Union
European Maritime and Fisheries Fund

Nordic Council of Ministers

INSTITUTE OF MARINE RESEARCH

Contents

Introduction

The participants of the project "Ecosystem Based FMSY Values in Fisheries Management", in short, the "MSY project", meet for the first time. The meeting took place at the facilities of the Nordic Council of Ministers, Copenhagen, Denmark, 20-21 June 2017. An Agenda for the meeting was send out beforehand, and is given in Appendix 1. The list of participants are given in Appendix 2. The present report is a Minutes report of the meeting.

Ray Hilborn, Petur Steingrund and Gunnar Stefansson could not come and the project leader Henrik Sparholt (HS) had a meeting with Petur Steingrund before the meeting, and will have meetings with Ray Hilborn and Gunnar Stefansson afterwards.

Geir Oddsson from the Nordic Council of Ministers participated for most of the meeting.

Adoption of agenda.

The agenda (Appendix 1) was adopted.

Funding agencies

HS presented the funding structure. The funding comes from European Maritime and Fisheries Fund & the Danish Ministry of Environment and Food (1.372 mio DKK), the Norwegian Fisheries Research Fund via IMR Norway (0.5 mio DKK) and from the Nordic Council of Ministers (0.5 mio DKK). The total budget for the project is therefore 3.057 mio DKK. The structure is a bit complicated and the diagram in Figure 1 below show how the funding are linked to recipients.

Funding agency	Work	Reciever of funds
NMR 0.5 mio DKK	Core project ECOSYSTEM Fmsy 2.535 mio DKK	NMTT 0.5 mio DKK
Norwegian Fiskerifond 0.5 mio DKK		IMR 0.5 mio DKK

EU (European Maritime and Fisheries Fund (EMFF)) and the Danish Ministry of Environment and Food (75% respectively 25% of 2.057 mio DKK	Extra and linked catch data project 0.522 mio DKK	NMTT 1.372 mio DKK	DPPO 0.546 mio DKK	EUFISH MEAL 0.139 mio DKK

Figure 1. The ECOSYSTEM Fmsy project in total 3.057 mio DKK, split by funding agency and by recipients.

Refreshing the project, plus new developments

Compared to the original project description, which was developed in 2016, an extra Work package 11 has been added, and extra money applied for and granted. This extra WP11 is about correcting the historical catch data for the stocks considered in the project. A co-operation with the two fishers' organizations, DPPO and EUFISHMEAL, has been established. These organizations have expertise about the possible corrections that may be needed for the ICES catch data. Because the project is based heavily on catch data, it is important to get as correct and unbiased catch data as possible.

HS presented the project, and the presentation is given in Appendix 3.

This project aims to incorporate density-dependent mortality, maturity, growth, in addition to recruitment, in the calculation of MSY-based reference points. It was pointed out that the density-dependent mortality can be compensatory (e.g., cannibalism) or depensatory (e.g., predation) even for the same species (e.g., cod).

The project is called "Ecosystem" MSY, but it is really "Single-species Plus" MSY. This "Plus" incorporate ecosystem considerations in the way of density dependence, which is how ecosystems works, because density dependence is due to changes in food availability, predation, diseases, and other ecosystem elements.

Where it occurs, density-dependent growth can compensate for the decline in stock size with fishing (e.g., North Sea cod, Baltic Sea sprat).

Is Fmsy an intrinsic property of a stock, or can it only be defined in the context of an exploitation pattern? Fmsy has been treated as a leading parameter of production models and age-structured models (e.g. Martell, CJFAS). However, these calculations are generally conducted assuming that the exploitation pattern is fixed in time; if not, Fmsy would change. The current procedure for calculating Fmsy in ICES is based on a stochastic control rule with a hockey-stick shape.

PROST is an MSE tool that contains an age-structured operating model with parameters taken from stock-assessment values.

Time line

Due to delay in the start-up of the project because of late granting of funds and administrative complications mainly due to the complex funding structure, the original time line had to be revised slightly. The new time line of the project is given below in Figure 2.

WP number	WP name	Q2 2017	Q3 2017	Q4 2017	Q1 2018	Q2 2018	Q3 2018	Q4 2018
1	F common currency							
2	Regime shifts, climate changes, genetic changes due to fishing, and suspected misreporting historically.							
3	Fmsy from ecosystem models							
4	Production models Fmsy							
5	Density dependent growth and maturity including PROST runs							
6	Life history pamaters							
7	GLM on ecosystem Fmsy							
8	Implementation/impact							
9	Concluding work and a final symposium							
10	Administration, meetings and homepage							
11	Catch data improvements							

Figure 2. Time line of MSY project.

Outcome of the project (conference, papers, presentations, popular version, …)

The conference in October 2018 will be in Copenhagen. It will start at mid-day one day, and end at mid-day the next day. There will be a conference dinner in the evening paid by the project. Dates are tentatively 11 and 12 October 2018.

We should invite scientists, managers and stakeholders (industry, NGOs). The primary focus will be on scientists as the project is manly a science project.

There is a gender issue in the project and it will be useful to invite especially female presenters to the conference and to future project meetings. Joanne Morgan, Eva Plaganyi, Clara Ulrich, Anna Rindorf, and Kristin Holsman were suggested.

Prior to the conference it is relevant to involve ICES experts through for instance "the Workshop to review the ICES advisory framework for short lived species, including detailed exploration of the use of escapement strategies and forecast methods" (WKMSYREF). The WK chairs Jose de Oliveira and Knut Korsbrekke will be contacted, and asked for the possibility to include a ToR for the next WKMSYREF meeting about the issue of our project. HS should offer to give a project presentation at that WKMSYREF meeting. HS will talk to Jose de Oliveira in ICES in Copenhagen during a training course 28 Aug-3 Sept 2017. Daniel Howell will talk to Knut Korsbrekke in Norway. There should be openness about the project.

If observers are approved by the chair of the present project, it should be fine to have such observers participating. We, however, don't want to have political discussions in our work – the focus is science. Because we will have results to present at our next meeting it should be okay to let approved observers participate at the next meeting, e.g., Martin Pastors, Steve Mackinson, and Gjert Dingsør.

It was approved to have the project and ideas presented at the project homepage (still to be developed).

Work packages

We discussed shortly again the content of each package in the light of the new knowledge from Froese et al and Hilborn, as well as of the extra linked project.

HS will update the stock list and distribute to all as soon as possible. The basis should be the ICES 2016 Advice Report. Two USA stocks should be added, striped bass and summer flounder at the east coast of USA. Only data rich stocks with estimates of absolute F should be included. It was suggested that also menhaden could be added and this will be looked into.

WP 1

Jan Horbowy circulated notes beforehand about how to equate Fmsy from age-structured and surplus-production models.

"Some thoughts on the "currency". In my understanding the fishing mortality in production models (SPM) may have interpretation of F-at-age from age-structured models weighted by biomass of age groups. In SPM we have

dB/dt=rB(1-B/K)-FB

In both age-structured and SPM fishing mortality may be expressed as catch divided by average biomass (average over period catch was collected), C/avB

So, if a denotes age, Fa=Ca/avBa in age-structured models

and

F=C/avB in SPM

Taking average of Fa weighted by biomass of age-groups we get

*Faverage= (1/∑ avBa)∑ Fa avBa =(1/∑ avBa)∑ Ca/avBa * avBa = C/avB,*

where all summations are over a.

In age-structured assessments within ICES fishing mortality (Fbar) is usually taken as arithmetic average of F-at-age for selected age groups. So, in cases when arithmetic and weighted averages show larger differences we may need some rescaling.

In these calculations one needs to apply average TSB which is obtained as sum of products of average N & w by age groups. Average N in interval [t,t+1] for given age-group is

avN(t,t+1)=N(t)(1-exp(-Z))/Z (age index omitted for simplicity)*

When I use avN formulae in both:

- *estimating of average F weighted by biomass of age-groups*
- *estimating averageTSB to get average F as Catch/avTSB*

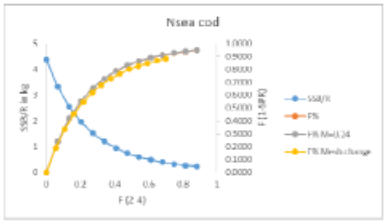
I get very similar estimates of F (I checked it for sprat, relative difference of <1%). "

HS had tried this on North Sea cod and found problems. Generally, Catch/avTSB was only about 60% of AvFweighted by biomass of age-groups. However, it was suggested that this could be due to the averaging of TSB (which is average of TSB at year start and TSB at year end). The TSB at year end was taken by HS as TBS at year start the following year, but this include the new recruits and these should be left out. This will of course decrease the avTSB in the calculations and thus increase the catch/avTSB. After the meeting this was done and the result is that catch/avTSB is still lower, 76%, of avFweighted. More tests seem to be needed. Maybe it is special for North Sea cod that the two values don't compare, because this cod assessment are maybe estimating misreporting in catches and how this is reflected in the summary table is maybe deviating from the normal standard.

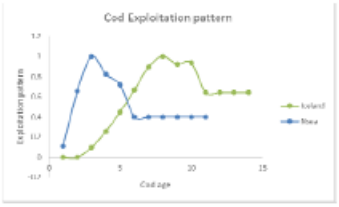
The Spawning Potential Ratio (SPR) is a "common currency" measure of fishing pressure that is independent of exploitation pattern and mainly reflects the impact the fishing has on the stock. It can be calculated as: 1- Ratio of (SSB/R at Fcurrent) to (SSB/R at F=0). The concept was developed by Philip Goodyear (1977 and 1993) and further explored by Cordue (2012). :

There are challenges associated with its calculation. The calculation of SPR is based on age-specific natural mortality and maturity; these input assumptions affect the ratio. Density dependence in growth, maturity and mortality cannot be easily taken account of neither. However, these factors might not matter very much. Sensitivity analysis made below showed that.

Mesh size change so that exploitation pattern move 1 age group "up", i.e. F age 1 becomes F age 2, etc.



Maybe F(2-4) NSea cod corresonds to 50%F(5-10) Iceland cod



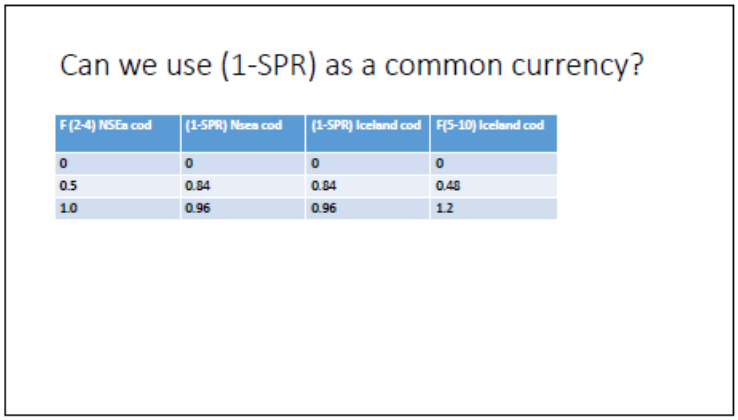


Figure 3 . SPR illustrations based on cod in the North Sea and cod in Iceland, with very different exploitation pattern.

From the last slide in Figure 3 showed that maybe the common currency F is not a big problem as a given F (age 2-4) for North Sea cod had a very similar effect on the stock as measured in SPR as the same value of F (age 5-10) for Iceland cod, and shifting the exploitation on North Sea cod one age "down" so to say, meaning that F on age 1 becomes F at age 2, F at age 2 becomes F at age 3 etc., did not neither change the SPR very much.

WP2

Regime shifts, it may be necessary to separate time series of data into appropriate periods in such cases.

Maybe mega trends of increases in pelagic stocks in the Northeast Atlantic could be used to indicate regime shifts – in a rough way.

WP3

Compile ecosystem and multispecies Fmsy from "published" work (also WG reports, Working Documents, if sound etc…), add short description of the model/assumptions used. It should refer to current situation, however, one may omit "problematic data" years.

To study literature, 5-10 years back, consider Review 2008 and 2012 by the ICES Multispecies WG.

May be separate it by eco-regions and assign responsible persons by eco-regions.

WP4

Use ICES summary tables as input data, fit stock-production models (SPM).

The criteria for using the ICES assessment data/results for SPM fits should be developed (e.g. contrast in F is required).

HS presented a suggestion for criteria for leaving out of a stock from the analysis:

1. Stock unit not well defined, e.g. cod WScot.
2. Catch data far from reliable.
3. Stock that have demonstrated large changes in carrying capacity.
4. Stocks with one or a few very large year classes in its historical time series are not suitable because the historical stock development will be driven by these year classes and mask the density dependent dynamics of the stock, e.g. W horse mackerel, maybe North Sea haddock and NSSP herring).
5. Stocks with suddenly strong parasites or diseases events or starvation – or at least these periods should be left out, e.g. cod Baltic SD2532.
6. Stocks with little dynamic range in catch and SSB.
7. Stocks with short time series.
8. Stocks with large changes in exploitation pattern over the time span considered, e.g. NSSP herring.
9. Stocks which gives very different temporal stock biomass development using surplus production models (like by Froese et al 2016) than the ICES estimated temporal biomass development.
10. Stock like cod WScot, where stock development obviously driven by some (unknown) environmental factors that goes clear against normal population regulation mechanisms. For cod WScot the stock is increasing in spite of increasing catches over time.
11. Stocks where predation pressure has varied strongly over time, e.g. Baltic sprat due to large changes in the cod SD2523 stock. Maybe a shorter time series can be used.

The list of criteria to be used for selection of stocks for running SPMs should be finalized before the next meeting.

It was suggested to do some sensitivity analysis on importance of the criteria, e.g. if in the first part of a time series catches are biased, and the caches are considered reliable in the following years, run models for two periods separately and compare the results (i.e. model parameter estimates and MSY parameters).

Ray's method to regress surplus-production against biomass, estimate parameters of the production model from the regression, should be explored.

Problems with discards: including in the assessment recent levels of discards and projecting backwards may not necessary be the right way of dealing with discards. Follow what WGs have done in the

assessment, in addition some sensitivity analysis of possible discard effects on assessment results could be made.

Froese et al (2016) have done the calculations already, but we should redo them. For instance his chosen time series length seems short. HS showed the plot of Fmsy estimated by multiplying Fmsy/F from Froese et al with F from ICES assessment for North Sea cod for 2000-2014 (Figure 4). Ideally, it should be constant, but there is a time trend which must be due mainly to difference in time trend between Froese et al and ICES assessment. Probably the last couple of years should not be included due to the convergence problems in ICES assessment.

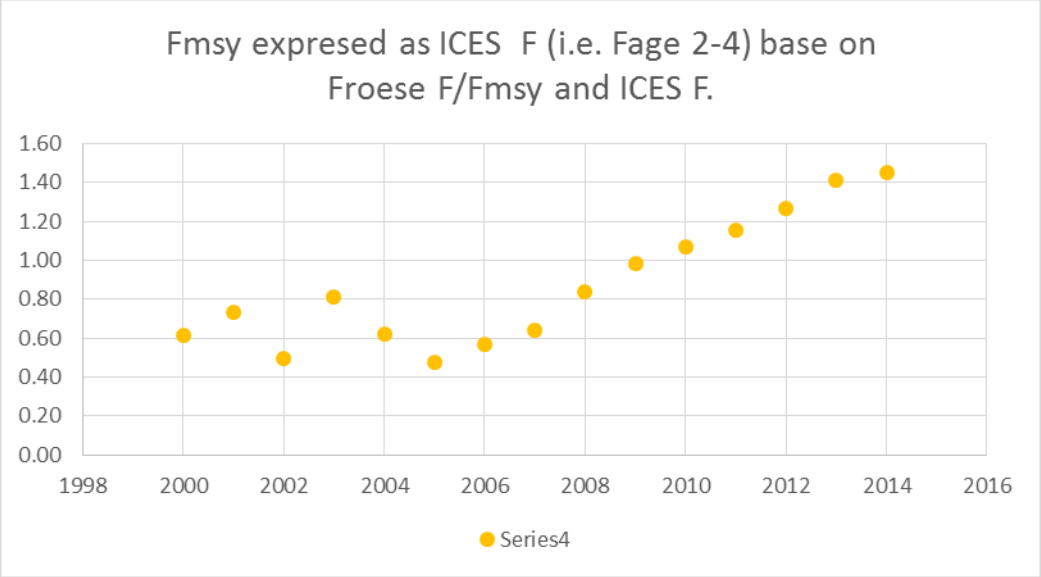


Figure 4. Fmsy estimated from Froese et al 2016 in combination with ICES assessment of F by year.

It is the general experience that Fcurrent/Fmsy is much better estimated than Fcurrent and Fmsy individually, in SPM, e.g. Berg (2016). This means that we do not need to translate F from the SPM "world" to a common currency, because we just multiply Fmsy/Fcurrent from SPM with Fcurrent from ICES assessments and we have Fmsy in the ICES currency.

There are very long time series now (up to 300 years) for Faroe Island cod, saithe and haddock and it might be useful to try SPM on these time series. At least the time series back to 1906 are of a high quality according to Petur.

It was discussed what biomass is estimated in SPM. This is in principle the biomass that it is tuned to, times some catchability parameter estimated. It should be exploitable biomass, at least if exploitable biomass is zero then the catch should also be zero.

Software-wise SPiCT from Casper Berg, DTU AQUA seems to be worthwhile looking into as a better option than ASPIC. HS, Søren and Claus will contact Casper.

WP5

Scientific knowledge on density dependent (DD) effects on growth, maturity, and cannibalism should be reviewed – partly basing on published reviews.

We should do meta-analysis on weight-at-age in the stock (WEST), and maturity against stock biomass.

We could repeat K. Brander analysis of DD growth for cod stocks in the North Atlantic now we have many more data years and better contrast in fishing mortality.

Cannibalism in cod stocks are well known. Hake probably also are cannibals. Blue whiting stomach have shown to have a few % juvenile blue whiting in the stomach, and this might be enough to have an effect on mortality. The same with mackerel, where the 1981 stomach sampling project have some data, but recent spawning along the Norwegian coast and in the inner Danish waters might mean that there now a days are more overlap between adults and juvenile mackerel.

Ray has a former student who might be interested in working on this.

WP6

Potential metrics to use is maximum age, age at 50% maturity, L_{oo}, steepness in the stock recruitment relationship and probably more. The plan is to invite Henrik Gislason, John Pope and Joanne Morgan to our next meeting and discuss among other thing this issue with them.

WP7

Consider the use of other F metrics in the GLM, e.g. Cordue (2012) “F”.

To use one set of life parameters (as determinants of MSY parameters for all considered stocks) in the GLM model of Fmsy.

WP8

Management Strategy Evaluation meetings might be a better place to do ICES evaluations of the Fmsy than ICES benchmark WGs.

Theme session at ICES: necessary to fill in the appropriate form, justification etc. HS will make suggestions on theme sessions and send around.

WP9

PA reference points (e.g. Fpa) in ICES are mainly estimated without DD effects (usually only S-R is considered), to be consistent with our Fmsy estimates which will include DD effects, it may be necessary to re-estimate PA points taking into account DD effects (e.g. in growth, M, maturity).

Final conference – mainly to report results, but also to get input from others.

We also have an obligation to present our results in popular ways for stakeholders. A one page illustration of the issue was recommended and an example was presented of that – an infogram we think it is called.

Assignment to work packages

The aim here is go through each WP and assign lead person and members. We went through the proposal from spring 2017.

The revised assignment is given below.

Item	Bjarte	Daniel	Claus	Gunnar	Henrik	Jan	Jeremy	Postdoc	Petur	Ray	Søren	Villy	Steve Mac
Work package 1. "Common currency" of F		x		x	C	x							
Work package 2. Regime shifts, climate changes, genetic changes due to fishing, and suspected misreporting historically (strong link to WP 11).	x		x	x	x	x			C	x	x	x	
Work package 3. Compile ecosystem and multispecies estimates of Fmsy	x	C		x		x	x		x			x	x
Work package 4. Surplus production model estimates of Fmsy				x	x	C		x		x			
Work package 5. Density dependent growth, maturity and cannibalism.	C				x		x	x	x	x			
Work package 6. Life history parameters relevant for Fmsy.					x	x	x		x	x		C	
Work package 7. GLM type analysis to "export" ecosystem Fmsy	x	x		C	x								
Work package 8. Implementation. (Presentations at various fora, including ICES EGs and ASC, ACs , 95% yield interval in Fmsy)	x	x	x	x	C	x	x	x	x	x	x	x	
Work package 9. Concluding work (1) report writing to funding agencies, 2) paper writing for scientific journal, 3) final conference)	x	x	x	x	C	x	x	x	x	x	x	x	
Work Package 10. Administration, meetings and homepage.					C			x					
Extra Work Package 11 (EU + Danish funded). Extra on misreporting in cooperation with fishers. Strong link to Sub WP 2 work package			C		x			x			x		
Number of Chairships	1	1	1	1	4	1	0	0	1	0	0	1	
Number of ordinary WP participations	5	4	3	5	6	6	4	6	5	6	4	5	
Sum	6	5	4	6	10	7	4	6	6	6	4	6	

We expect that Steve Mackinson will be interested in participating in the MSY project and he is suggested to be participating in WP3 due to his expertise in ecosystem models for the North Sea.

Petur has agreed to chair WP2. The Faroe Island cod and haddock stocks seems to be especially exposed to regime shifts and this is probably the ecosystem where we have best data on this.

Future meetings (dates, openness to observers, etc.)

It was agreed that our work should be as open as possible to the public. Observers and participants should be allowed and the ICES guidelines should be good and useful guidelines for the current project as well.

Thus, the chair of our meetings will have great flexibility to invite people. However, we should avoid politics to come into our work.

HS informed that there still are administrative aspects to be resolved of the project. He expect these to be finalized within the coming month or so. Thus, travel, per diem, and honorarium compensation are delayed until then.

Many of us will be at the ICES ASC in Florida in September. We should try to arrange a meeting then. Maybe Joanne Morgan, Henrik Gislason, John Pope and Yuri Kovalev will be there also, and we could invite them to discuss the various issues we have discussed for us to talk to them about.

It was agreed to meet in Vancouver 31 October to 2 November 2017, in Rhode Island, USA 12-14 March 2018, and have the conference 10-11 October 2018.

AOB

No issue was raised.

Closing

HS closed the meeting by thanking all the participants for intensive and constructive discussions and the Nordic Council of Ministers for letting us use their facilities.

References

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CP Goodyear. 1993. Spawning-stock biomass per recruit in fisheries management: foundation and current use. Can. Spec. Pub. Fish. Aquat. Sci.

Cordue, P. L. 2012. Fishing intensity metrics for use in overfishing determination. – ICES Journal of Marine Science, 69: 615–623.

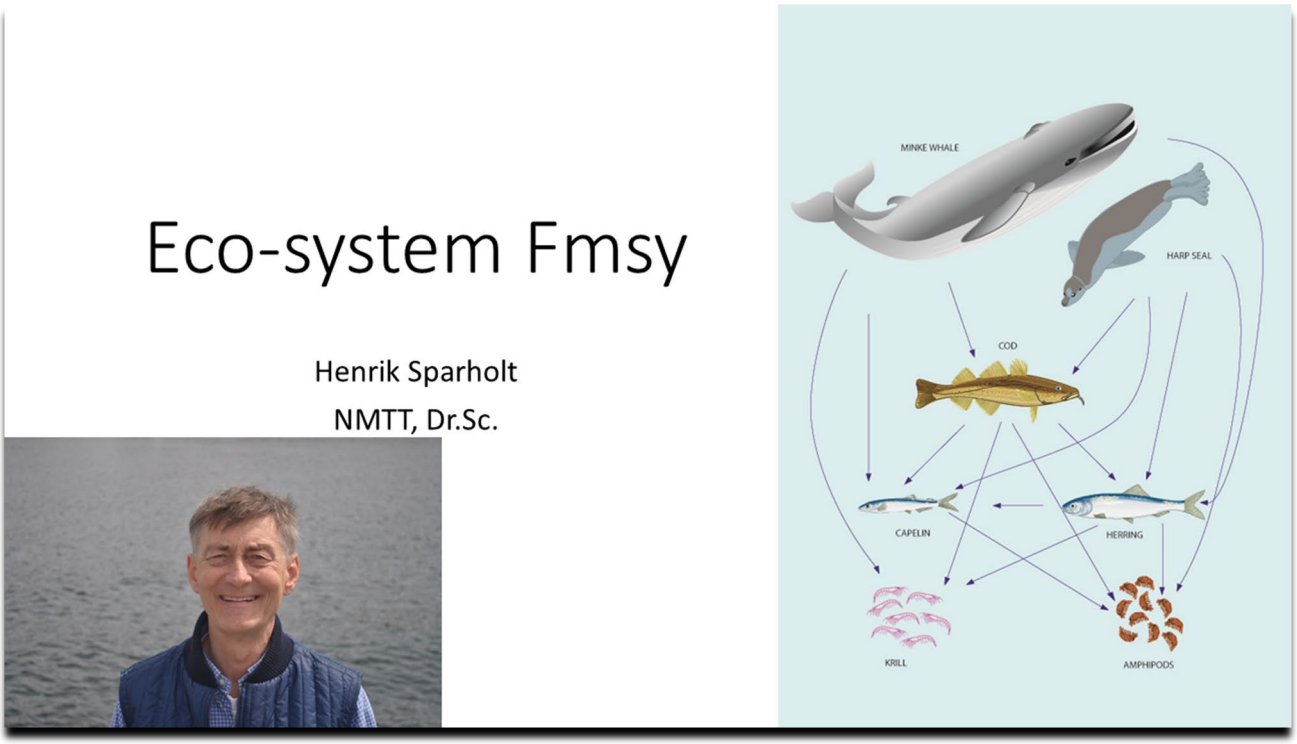
Appendix 1. Agenda and Minutes assignments

1. Welcome — HS
2. Adoption of agenda — Villy
3. Funding agencies — Claus
4. Refreshing the project, plus new developments — Jeremy
5. Time line — Daniel
6. Outcome of the project (conference, papers, presentations, popular version, …) — Søren
    a. Conference in 3Q 2018, 120 participants, from midday to midday
    b. Nature or Science?
    c. Popular version for news papers and other media
    d. A pamphlet
    e. Presentation at RCs, and similar places
    f. …
7. Work packages — Jan
    a. The aim here is to discuss shortly again the content of each package in the light of the new knowledge from Froese et al and Hilborn, as well as of the extra linked project.
8. Assignment to work packages — Claus
    a. The aim here is go through each WP and assign lead person and members. There are already a proposal from spring 2017.
    b.
9. Future meetings (dates, openness to observers, etc.) — Jeremy
10. Administrative aspects, travel, per diem, honorarium — Daniel
11. AOB — Villy
12. Closing — HS

Appendix 2. List of participants.

Participant name	**Participant organisation name**	**Country**
Henrik Sparholt (Chair)	Nordic Marine Think Tank (NMTT)	Denmark
Jan Horbowy	National Marine Fisheries Research Institute (NMFRI)	Poland
Jeremy Collie	University of Rhode Island	USA
Daniel Howell	Institute of Marine Research (IMR)	Norway
Villy Christensen	University of British Columbia	Canada
Søren Anker Pedersen	EUFISHMEAL	Denmark
Rob van Gemert	DTU AQUA	Denmark
Claus Sparrevohn	DPPO	Denmark

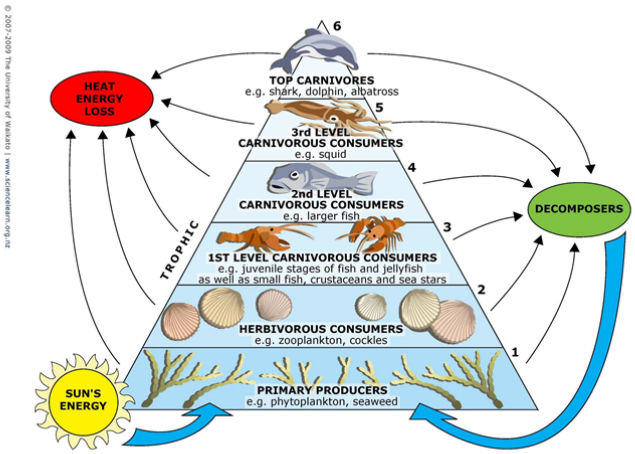
Appendix 3. Presentation of the project.



Basic ecosystem concepts

1. The production in an ecosystem is based on primary production.
2. This production is moving up the food web.
3. <u>If fishing is too light:</u> the fish stocks will be too large and burn too much production in metabolic maintenance (convert production to $C0_2$) - production which could otherwise have been harvested as fish meat.
4. <u>If the fishing is too hard:</u> the fish stocks will be too small and not produce enough juveniles.

Ecosystem productivity



Graham 1947, Beverton&Holt 1957, Ricker 1958, Hilborn&Walters 1992, Longhurst 2010, and many others…

Longhurst, A. 2010. Mismanagement of marine fisheries. Cambridge University Press, Cambridge, UK:

" For any level of fishery harvest to be sustainable, some or all of the biological processes contributing to production must be compensatory, i.e. increasing as stock biomass decreases…"

Four compensatory mechanisms –

	Taken into account in current management?
• Density dependent recruitment	√
• Density dependent individual fish growth	Not yet
• Density dependent mortality	Not yet
• Density dependent maturity	Not yet

Missing any of these in Fmsy calculations will give a downward bias!

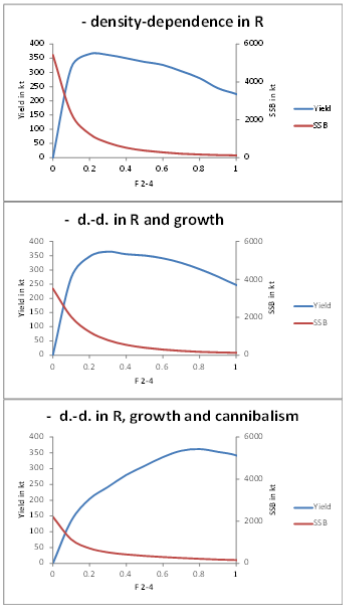
...and of course, scientific advice should be unbiased

ICES Strategic Plan 2014–2018:

" …commitment to maintain ICES as a strong and independent scientific organization in order to improve its capacity to give unbiased, sound, reliable, and credible scientific advice on human activities affecting, and affected by, marine ecosystems;"

Example:

Yield/SSB
vs
Fishing pressure

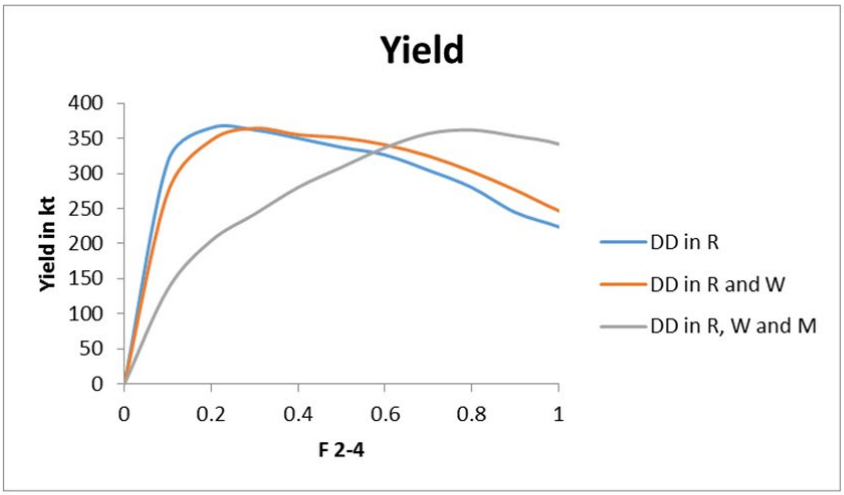


	Fmsy
- density-dependence in R	0.20
- d.-d. in R and growth	0.30
- d.-d. in R, growth and cannibalism	0.70

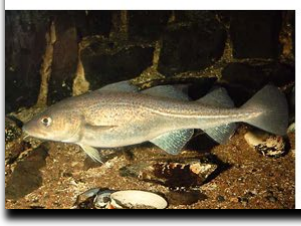
North Sea cod

Example:

Yield
vs
Fishing pressure

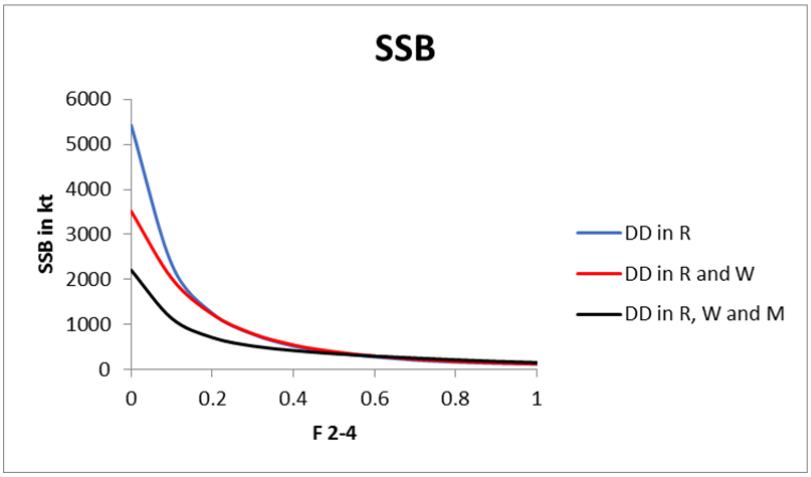


North Sea cod



Example:

SSB
vs
Fishing pressure



North Sea cod

Magnuson-Stevens Fisheries Conservation and Management Act (FCMA) (…and FAO, EU, …)

"…managers are required to use the best scientific information available…".

And ICES:

"ICES advice is produced through a process which is set up to ensure that the advice is based on the best available science and data…"

http://www.ices.dk/community/advisory-process/Pages/Basis-for-ICES-Advice.aspx

Available science in ecosystem functioning

- over four decades of intensive research
- hundreds of peer reviewed papers has been published
- more than 1.5 million fish stomachs analyzed
- hundreds of person-years spend on fish evacuation experiments
- a multitude of models developed.

Why wait another 30 years to use the obtained knowledge?

Let us pick the low hanging fruits now.

The project aim:

> Bridging the ”gap between science and fisheries advice/management”.

Like today, managers still do <u>not</u> need to consider the balance between species for using the proposed set of F_{MSY} values.

- The project does not aim for a full multispecies approach, …but much closer to it than the current approach.
- The focus will be on adding mainly density dependent growth, maturity and (if relevant) cannibalism, to the current single species way of estimating F_{MSY}.
- The lack of full multispecies approach means that the new FMSY values should only be regarded as valid for say 5 years, before being renewed. Stock sizes can for this short time period be considered reasonable constant and thus species-interactions parameters as well.

Two basic ideas

- GLM type approach to ”spread” the available ecosystem Fmsy to all stocks
- Use of Surplus Production Models - that implicitly includes all 4 density dependent elements - on the existing stock assessment time series of catch, F and SSB

Ultimate product of the project will be this table (tentatively filled in with values for ”Fmsy ecosystem” column).

Stock	Fmsy Current	Fmsy ecosystem
Blue whiting in Subareas I-IX. XII and XIV (Combined stock)	0.30	0.4
Cod in Division Va (Icelandic cod)		0.5
Cod in Division VIa (West of Scotland)	0.19	0.6
Cod in Division VIIa (Irish Sea)	0.40	0.7
Cod in Divisions VIIe-k (Celtic Sea cod)	0.40	0.7
Cod in Subarea IV (North Sea). Divison VIId (Eastern Channel) and IIIa West (Skagerrak)	0.19	0.7
Cod in Subareas I and II (Northeast Arctic cod)	0.40	0.4
Cod in Subdivision Vb1 (Faroe Plateau)	0.32	0.5
Cod in Subdivisions 22-24 (Western Baltic Sea)	0.26	0.7
Cod in Subdivisions 25-32 (Eastern Baltic Sea)	0.46	0.6
Haddock in Division Va (Icelandic haddock)		0.4
Haddock in Division Vb	0.25	0.4
Haddock in Division VIb (Rockall)	0.20	0.4
Haddock in Division VIIa (Irish Sea)		0.5
Haddock in Divisions VIIb.c.e-k	0.33	0.5
Haddock in Subarea IV and Divisions IIIa West and VIa (North Sea. Skagerrak and West of Scotland)	0.35	0.5


Thank you !