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Interim Report of the Working Group on Fisheries–Induced Evolution (WGEVO)

7–11 July 2014

IJmuiden, the Netherlands



ICES

International Council for
the Exploration of the Sea

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International Council for the Exploration of the Sea Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Executive summary

The Working Group on Fisheries-induced Evolution (WGEVO) met during 7–11 July 2014 at the Institute for Marine Resources and Ecosystem Studies in IJmuiden, the Netherlands. WGEVO strives to (i) assemble and review empirical evidence of fisheries-induced evolution and its consequences for the conservation of biodiversity and sustainable exploitation of marine species within an ecosystem context, (ii) apply and extend the framework for evolutionary impact assessments, and (iii) develop scientific and methodological tools to monitor and respond appropriately to risks to biodiversity and sustainable exploitation posed by fisheries-induced evolution, with a particular emphasis on making these tools readily available for a broader range of scientists and managers. During this meeting, the working group's efforts focused on advancing the estimation of fisheries-induced selection pressures (FISPs) for a range of 26 exploited fish stocks. To this end, the WGEVO-developed FISP computational algorithm has been improved and implemented in R, a corresponding user manual has been prepared, and parameters required for FISP computation have been estimated from survey data and market data. As a result, FISP estimates have been completed for 14 stocks and are in progress for 12 additional stocks. A collaborative scientific article comprehensively reviewing and analysing these results is in preparation.

1 Administrative Details

<p>Working group name</p> <p>Working Group on Fisheries-Induced Evolution (WGEVO)</p> <p>Year of appointment</p> <p>2013</p> <p>Reporting year within current cycle</p> <p>2</p> <p>Chairs</p> <p>Ulf Dieckmann, Austria</p> <p>Bruno Ernande, France</p> <p>Mikko Heino, Norway</p> <p>Meeting venue</p> <p>IJmuiden, the Netherlands</p> <p>Meeting dates</p> <p>7–11 July 2014</p>

2 Terms of Reference

ToR	Description	Background	Science plan topics addressed	Duration	Expected deliverables
a	Provide a forum for international collaboration and exchange of emerging scientific insights on fisheries-induced adaptive changes. The activities of WGEVO will provide ICES with a basis for advice on whether and how the effects of fisheries-induced adaptive change need to be taken into account in ecosystem approach to management.	The ecosystem approach to management is the overarching motive for ICES science and management.	121, 141,143, 211, 311, 312, 314, 344, 345, 346	Years 1, 2, 3	
b	Assemble and review empirical evidence of fisheries-induced adaptive change and its consequences for the conservation of biodiversity and sustainable exploitation of marine species within an ecosystem context.	a) Research beyond current Science Plan requirements b) Research for MSFD and GES requirements c) No requirements from other EGs	141, 143, 311, 312, 344	Years 1, 2	ICES publication for general audience, Wikipedia article

c	Apply the Evolutionary Impact Assessment framework to specific case studies to: (i) evaluate the impact of existing management measures on fisheries-induced adaptive change; (ii) relate consequences of fisheries-induced adaptive change to stakeholder utilities and to current management objectives; (iii) evaluate possible more specific objectives for managing fisheries-induced adaptive change.	a) Research beyond current Science Plan requirements b) Research for MSFD and GES requirements c) Links with relevant Assessment WGs required	211, 311, 312, 314, 344, 345	Years 1, 2, 3	Peer-reviewed publications
d	Develop scientific and methodological tools to monitor and respond appropriately to risks to biodiversity and sustainable exploitation posed by fisheries-induced adaptive change, with a particular emphasis on making these tools readily available for a broader range of scientists and managers.	a) Research beyond current Science Plan requirements b) Research for MSFD and GES requirements c) Links with relevant Assessment WGs required	121, 141, 143, 311	Years 1, 2	Tools (R-scripts), potentially accompanied by peer-reviewed publications, as the need might arise

3 Summary of Work Plan

Year	Main deliverable
1	ICES document providing an overview of FIE for a wider scientific audience and the general public; R-scripts for estimating selection differentials of exploited fish stocks
2	Review of selection differentials of exploited fish stocks
3	Evolutionary Impact Assessment (EvoIA) of a selected case study

4 List of Outcomes and Achievements of the Working Group in This Delivery Period

Estimation of fisheries-induced selection pressures (FISPs) for a range of exploited fish stocks

- FISP computational algorithm:
 - Clarification of the difference between annual and generation- based FISP; for the current project, annual estimates will be favoured
 - Clarification of the reference situation, exploited vs. virgin stocks, in relation to the scientific question tackled: evaluating immediate vs. long-term changes in selection differentials after stopping fishing; both options will be implemented
 - Comparison of different standardization methods to compare FISPs across traits, stocks, and species; mean standardized selection differentials have the necessary properties and will be used
 - Update of the FISP computational algorithm in R
- Selection and estimation of parameters required for FISP computation:

- Development of a standardized procedure for the selection and estimation of the parameters required to run the FISP computation algorithm in order to allow comparison across stocks and species
- Update of the scripts for parameter estimation in R
- Writing/updating of the user manual “Estimating selection differentials of multiple life-history traits with R”
- FISP estimation:
 - Completion of the estimation of FISPs for 14 stocks (Annex 3)
 - FISP estimation is currently in progress for 12 additional stocks (Annex 3)
 - Preliminary analyses of the effects of, and sensitivities to, various parameters involved in the estimation

Drafting of a collaborative publication tentatively titled “The strength of fishing-induced selection” to review and analyse FISPs estimated for a range of exploited fish stocks

- Drafting of manuscript outline
- Drafting of introduction section
- Drafting of materials-and-methods section and corresponding appendices

Publication of two journal publications resulting from collaborative projects in this working group

- Heino, M., Baulier, L., Boukal, D. S., Ernande, B., Johnston, F. D., Mollet, F. M., Pardoe, H., Therkildsen, N. O., Uusi-Heikkilä, S., Vainikka, A., Arlinghaus, R., Dankel, D. J., Dunlop, E. S., Eikeset, A. M., Enberg, K., Engelhard, G. H., Jørgensen, C., Laugen, A. T., Matsumura, S., Nusslé, S., Urbach, D., Whitlock, R., Rijnsdorp, A. D., and Dieckmann, U. 2013. **Can fisheries-induced evolution shift reference points for fisheries management?** *ICES Journal of Marine Science*, 70: 707–721.
- Laugen, A. T., Engelhard, G. H., Whitlock, R., Arlinghaus, R., Dankel, D. J., Dunlop, E. S., Eikeset, A. M., Enberg, K., Jørgensen, C., Matsumura, S., Nusslé, S., Urbach, D., Baulier, L., Boukal, D. S., Ernande, B., Johnston, F. D., Mollet, F., Pardoe, H., Therkildsen, N. O., Uusi-Heikkilä, S., Vainikka, A., Heino, M., Rijnsdorp, A. D., and Dieckmann, U. 2014. **Evolutionary impact assessment: accounting for evolutionary consequences of fishing in an ecosystem approach to fisheries management.** *Fish and Fisheries*, 15: 65–96.

Organization of the 2014 ICES ASC Theme Session E “Stocks in flux: From selection pressures via phenotypic and genetic adaptive responses to impacts on ecosystem service”

- The working group is centrally involved in organizing the theme session “Stocks in flux: From selection pressures via phenotypic and genetic adaptive responses to impacts on ecosystem service” at the 2014 ICES Annual Science Conference in A Coruña.
- As part of this session, the working group’s project on fishing-induced selection pressures will be featured through a talk and a poster.

5 Progress Report on ToRs and Work Plan

Progress by ToR

- *ToR a: Provide a forum for international collaboration and exchange of emerging scientific insights on fisheries-induced adaptive changes.*
The working group has met once per year, and in 2014 will meet even twice. The working group is also centrally involved in organizing a theme session at the 2014 ICES Annual Science Conference, providing an even wider forum for the exchange of results and ideas.
- *ToR b: Assemble and review empirical evidence of fisheries-induced adaptive change and its consequences for the conservation of biodiversity and sustainable exploitation of marine species within an ecosystem context.*
The working group is keeping a database on published studies on fisheries-induced evolution, in particular in age- and size-at-maturation.
- *ToR c: Apply the Evolutionary Impact Assessment framework to specific case studies...*
Members of the working group are continuing to develop an EvoIA for North Sea plaice.
- *Develop scientific and methodological tools to monitor and respond appropriately to risks to biodiversity and sustainable exploitation posed by fisheries-induced adaptive change...*
The working group has continued to refine the general framework for assessing fisheries-induced selection pressures. The framework has now attained maturity and we are reaching out to wider a wider group of scientists to apply it.

Science Highlights

- The two journal articles produced by WGEVO and published in 2013/2014 present the most up-to-date overview of the expected individual, population, and fishery-level consequences of fisheries-induced evolution, as well as its consequences for reference points for fisheries management (Heino *et al.* 2013; full reference in Section 4), and a general framework for assessing the management implications of fisheries-induced evolution through Evolutionary Impact Assessments (EvoIAs; Laugen *et al.* 2014; full reference in Section 4).

6 Revisions to the Work Plan and Justification

The working group has adjusted the timeline for preparing the ICES document providing an overview of fisheries-induced evolution for a wider scientific audience and the general public, a deliverable originally foreseen for year 1. This task will be resumed once the project on fishing-induced selection pressures is near completion, likely early in 2015, so the results from that project can be included in that overview document.

7 Next Meetings

The working group has agreed to meet next during 1–5 December 2014 at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, near Vienna, Austria, and during 7–11 September 2015 at Ifremer, Boulogne-sur-mer, France.

Annex 1: List of participants

NAME	ADDRESS	EMAIL
Asbjørn Christensen	DTU AQUA, National Institute of Aquatic Resources, Section for Marine Living Resource, Technical University of Denmark, Charlottenlund Slot Jægersborg Allé 1, 2920 Charlottenlund, Denmark	asc@aqua.dtu.dk
Ulf Dieckmann (Chair)	International Institute for Applied Systems Analysis, Evolution and Ecology Program, Schlossplatz 1, 2361 Laxenburg, Austria	dieckmann@iiasa.ac.at
Bruno Ernande (Chair)	Ifremer, Unité Halieutique Manche-Mer du Nord, 150 quai Gambetta, PO Box 32, 62200 Boulogne-sur-mer, France	bruno.ernande@ifremer.fr
Mikko Heino (Chair)	University of Bergen, Department of Biology, PO Box 7803, 5020 Bergen, Norway	mikko.heino@bio.uib.no
Ane Laugen	Swedish University of Agricultural Sciences, Department of Ecology, Box 7044, 750 07 Uppsala, Sweden	ane.laugen@slu.se
Shuichi Matsumura	Gifu University, Faculty of Applied Biological Sciences, 1-1 Yanagido, 501-1193 Gifu City, Japan	matsumur@gifu-u.ac.jp
Jan Jaap Poos	IMARES, Institute for Marine Resources and Ecosystem Studies, Haringkade 1, 1976 CP IJmuiden, the Netherlands	janjaap.poos@wur.nl
Adriaan Rijnsdorp	IMARES, Institute for Marine Resources and Ecosystem Studies, Haringkade 1, 1976 CP IJmuiden, the Netherlands	adriaan.rijnsdorp@wur.nl

Annex 2: Recommendations

None.

Annex 3: Case Studies for the Stock-specific Estimation of Fisheries-induced Selection Pressures (FISPs)

	Species	M/F ¹	Stock/region	ICES area	Data source	Status
1	Blue whiting	M	NE Atlantic	I-IX, XII, XIV	Survey	Done
2	Cod	M	W Baltic Sea	IIIb-c	Survey	Done
3	Cod	M	North Sea	IV	Survey ²	Done
4	Haddock	M	Barents Sea	I	Survey	Done
5	Herring	M	North Sea	IV	Survey ²	Done
6	Mackerel	M	NE Atlantic	II-IX, XII, XIV	Survey	Done
7	Northern pike	F	Wisconsin Lakes	n.a.		Done
8	Plaice	M	North Sea	IV	Survey & market	Done
9	Sole	M	North Sea	IV	Survey & market	Done
10	Sole	M	E. Channel	VIIId	Survey ³ & market	Done
11	Sole	M	W. Channel	VIIe	Market	Done
12	Sole	M	Bay of Biscay	VIIIa	Market	Done
13	Turbot	M	North Sea	IV	Survey & market	Done
14	Walleye	M	Wisconsin Lakes	n.a.		Done
15	Capelin	M	Barents Sea	I		In progress
16	Cod	M	NE Arctic	I-II		In progress
17	Cod	M	E Baltic Sea	IIIId		In progress
18	Cod	M	NW North Sea	n.a.		In progress
19	Haddock	M	North Sea	IV	Survey ²	In progress
20	Haddock	M	NW North Sea	n.a.		In progress
21	Herring	M	NSS/Norwegian Sea	II		In progress
22	Herring	M	E Baltic Sea	IIIId		In progress
23	Norway pout	M	North Sea	IV	Survey ²	In progress
24	Sole	M	Celtic Sea	VIII-f-g	Market	In progress
25	Sprat	M	Baltic Sea			In progress
26	Whiting	M	North Sea	IV	Survey ²	In progress

¹ Marine/Freshwater

² International Bottom Trawl Survey

³ Channel Ground Fish Survey