Project no': **FP6- 022710**
Project acronym: IN EX FISH
Project title: Incorporating extrinsic drivers into fisheries management

Instrument: coordination action

Thematic Priority: Scientific Support to Policy

Publishable final activity report

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Project coordinator name: Prof. C. L. J. Frid
Project coordinator organisation name: University of Liverpool   Revision [2]

Publishable final activity report for INEXFISH

1. Project Execution
Summary description of project objectives

The INEXFISH project has four specific and verifiable scientific and technical objectives. These are:

Box.1

1. To provide a state of the art review of the impact of anthropogenic and non-anthropogenic factors on the dynamics of fish stocks.
2. To develop a framework for the systematic evaluation of the impacts of anthropogenic and non-anthropogenic factors on the dynamics of exploited fish species.
3. To develop criteria for the selection of appropriate metrics, to review available metrics of ecosystem status, to select those that match the criteria and establish reference levels in the four geographic regions for these metrics.
4. To incorporate IN EX FISH knowledge of anthropogenic and non-anthropogenic effects into fisheries management.

Contractors

Partner	Institution address
1	School of Biological Sciences, University of Liverpool, Crown Street, Liverpool, L69 7ZB, England.
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3	Marine Research Institute (MRI), Skulagata 4, P.O. Box 1390, 121 Reykjavik, Iceland.
4	Wageningen IMARES – the Institute for Marine Resources and Ecosystem Studies, Haringkade 1, 1976, CP IJmuiden , The Netherlands.
5	Heinrich-Heine Universität Düsseldorf (UDUS), Institut für Zoophysiologie, Lehrstuhl für Stoffwechselphysiologie, Heinrich-Heine Universität, D-40225, Düsseldorf, Germany.
6	Sea Fisheries Institute/Morski Instytut Rybacki, Kołłątaja 1, 81-332, Gdynia, Poland.
7	University of Bari (UBARI), Department of Animal Health and Well-being Faculty of Veterinary Medicine - University of Bari, Str. Prov.le per Casamassima, km 3 70010 Valenzano (Bari) Italy.
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Work performed
The overall objectives of INEXFISH (Box 1) enable the incorporation of the effects of extrinsic drivers into fisheries management. The approach which INEXFISH took to achieve this goal is shown in Figure 1.

The first objective, the review part of INEXFISH (Scott *et al*., 2006) which focused on assessing the impact of anthropogenic and non-anthropogenic factors (extrinsic drivers) on the dynamics of fish stocks is available on the INEXFISH website (www.inexfish.org). The published review was the culmination of: a review of information from a range of sources including published and unpublished scientific literature from the laboratory and field and a workshop consisting of INEXFISH members and experts on anthropogenic and non-anthropogenic extrinsic drivers. During the workshop, the participants -- from European and Non-European academic, industrial and government organisations -- consulted on, calculated and graded the effect of a large suite of extrinsic drivers on the biology of exploited species.

Determining and assessing the role of anthropogenic and non-anthropogenic forcing extrinsic drivers on the biology of exploited species, allowed identification of those that are significant.

The following extrinsic drivers (also known as factors) were considered the most important for fish stocks:

- Changes in temperature (including, for example, ambient temperature or sea surface temperature);
- Changes in the atmosphere-ocean system (such as those indicated by the North Atlantic Oscillation index);
- Changes in prey abundance (species diversity and abundance);
- Changes in habitat structure;
- Changes in toxic load (including incidence of eutrophication or body load of pollutants);
- Changes in natural mortality, and
- Degree of fishing mortality

Changes in populations' dynamics, as a function of biological processes: recruitment, growth rate; condition (K); age of maturity; fecundity; reproductive output; size-structure of the stock, can be identified by monitoring changes in the above extrinsic drivers. The effects of these drivers are, however, not generic – stocks are affected to a lesser or greater extent through a variety of indirect and direct processes.

The significant extrinsic drivers identified in the review provided the core of the framework for the next phase of INEXFISH; initiating the metric selection aspect of our work and four case studies. INEXFISH had four case studies studying distinct, ecologically contrasting, geographic areas: North Atlantic (North Sea, Western Scotland and Icelandic waters) (Piet *et al*., 2008); Baltic Sea (Margonski *et al*., 2008); Iberian waters (Borges *et al*., 2008) and the Mediterranean Sea (De Meterio *et al*., 2008). Each case study hosted expert group workshops where: management incorporation of anthropogenic and non-anthropogenic extrinsic drivers has been reviewed; the effect of environmental factors on populations/stocks investigated and quantified; models investigated/utilised and metrics applied.

The devised framework (INEXFISH Metrics report; Hansson *et al*., 2008) focused on the important extrinsic drivers, to hone our analyses by concentrating on the important drivers rather than a whole suite of possible drivers.

Metrics were assessed to determine if they could be used effectively and consistently. Criteria were used, such as:

· **'Concreteness'** -- does the metric represent a concrete physical or biological property?
· **'Availability of historical data'** -- is the necessary data available to carry out studies?
· **'Responsiveness'** -- does the metric change promptly after change in the forcing factor or does it have a very slow response?
· '**Generality**' -- is the metric useful/valid for most stocks and areas or is it very site and stock specific?

Adapted from Rice & Rochet (2005) ICES Journal of Marine Science 62:516-27; see Hansson et al., (2008) for further details.

The fish species to be considered in the future work were also honed (based on knowledge of their biology and population dynamics, and the existence of time series of sufficient length to demonstrate relationships at the population and community level). Care in the selection of species was also taken to choose comparable species in the ecologically contrasting case study areas, for example, cod as a species is considered in all the Northern Atlantic areas and the Baltic Sea. Additionally, some species which we wished to assess, e.g. Blue Whiting were dropped from the analyses since there is insufficient data to make effective assessments.

During the first phase of the case study process current management was examined to assess whether or not extrinsic drivers were included. Current fisheries management in all the case study areas does not incorporate extrinsic drivers. The North Atlantic and the Baltic regions have attempted to introduce fisheries management influenced by knowledge of the extrinsic drivers, especially for pelagic stocks. As no management framework includes extrinsic drivers the INEXFISH work and results will, therefore, extensively add to the knowledge base. Stakeholders who attended workshops indicated that they welcomed the inclusion of extrinsic drivers in the fisheries management process.

It appears that while there are common extrinsic drivers (e.g. temperature variability) common metrics applicable across the whole range of ecosystems types need to be carefully assessed since population responses can differ affecting comparisons between species/stocks in the different case study areas.

Figure 1. The main steps in the INEXFISH approach to bring extrinsic drivers into fisheries management.

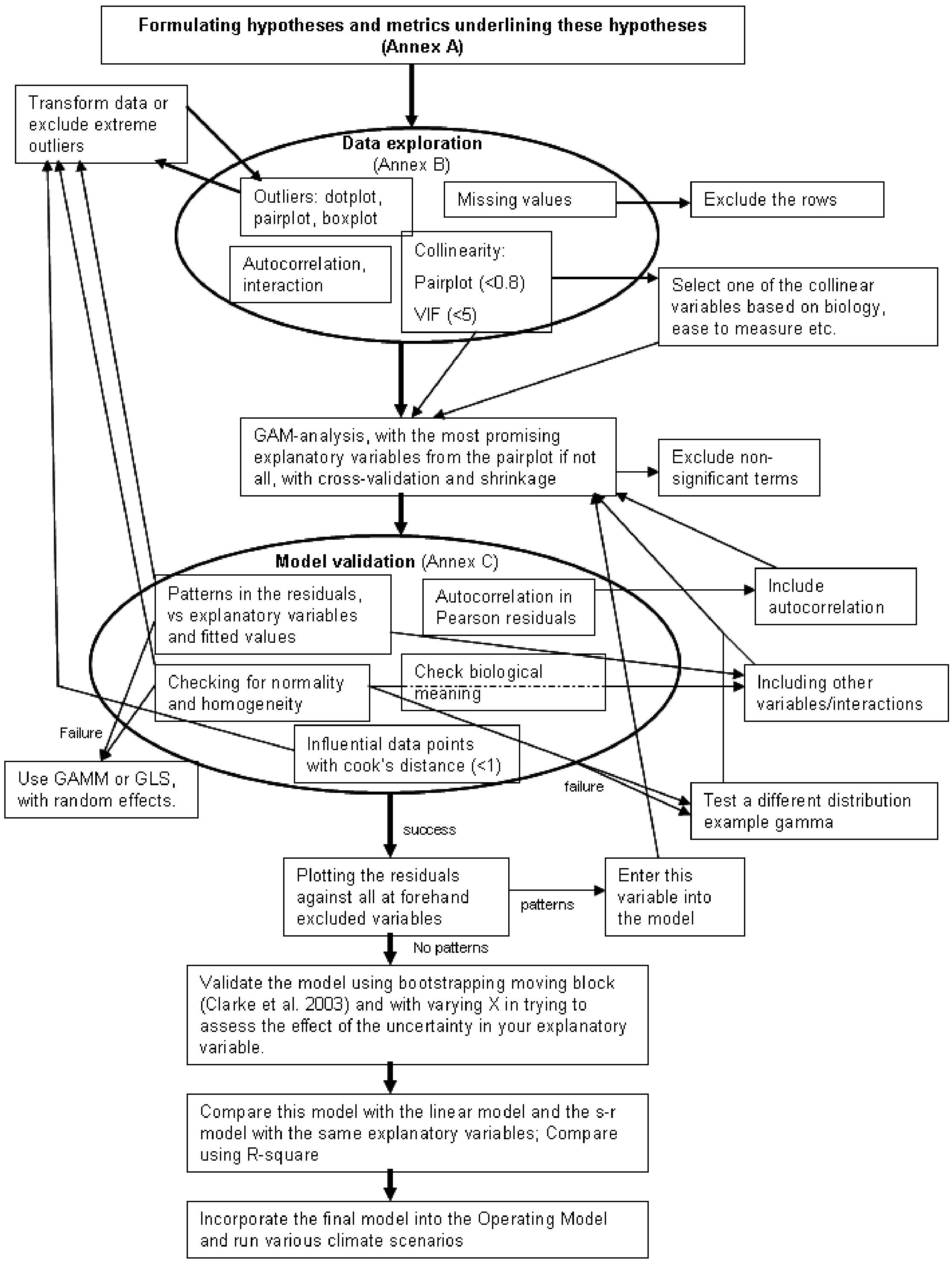

Figure 2. Flow diagram of methodology for GAM analyses.

Integral to INEXFISH an extensive study was carried out of the existing scientific analyses of the effect of extrinsic drivers on fish population dynamics in scientific literature and institute research. While information on possible relationships between the extrinsic drivers and the biological mechanisms exist, relationships were rarely described in a functional, quantifiable manner. To use extrinsic drivers in predictive, consistent fisheries management unconditionally necessitates determination of such relationships.

Given that there were few assessments which quantified the effect of extrinsic drivers on population dynamics, this necessitated that INEXFISH performed the analyses. Thus available, identified metrics/data were used in an INEXFISH derived common statistical framework (Figure 2). A non-parametric technique called generalised additive modelling (GAM) was used in the four INEXFISH case studies -- North Atlantic, Baltic, Iberian and Mediterranean Sea -- to derive the much needed quantified relationships.

Performing the GAM analyses, simultaneously achieved two aims:

1) Objectively selected metrics from a larger suite of biologically relevant metrics, and

2) Non-parametric, statistically ratified models linking change in a biological process to one or more extrinsic factors (described by various metrics) were developed.

The derived Spawning Stock-Recruitment with environmental variables (S-Re) GAM models in the different case studies are presented in Tables 1 and 2.

The identified SSB or SSB related metrics (such as age diversity of the stock) reflect the condition of the stock being modelled. As such, these metrics are predominantly affected by direct anthropogenic pressure, mainly fishing. As such information linked to these metrics can be incorporated into management, practically and theoretically.

The non-anthropogenic drivers cannot be controlled only understood, so management can better respond to change in environmental conditions. The models that have been derived independently for the different stocks are one step in this process.

While there are a small number of non-anthropogenic extrinsic drivers identified in the analyses there are two main types:

1) Large scale indices of ocean-atmosphere interactions such, as the North Atlantic Oscillation, the Baltic Sea Index or upwelling indexes.

2) Areal/chronological indexes i.e. a specific metric (e.g. Sea Surface Temperature) in a specific area often linked to a reproductive activity (e.g. spawning) during a certain time period.

There are two explanations why the climate types of metric dominate a) direct and indirect biological relevance i.e. acting on many aspects of the recruitment processes and, pragmatically, b) the data sets are of sufficient length to be used.

Table 1. The identified GAM relationships between recruitment variation and statistically derived metrics of the demersal species.

Species	Relationship	Trend favourable of unfavourable	Variance explained by the models (R^2) %
Icelandic cod	R ~ s(Shannon index)	Positive relationship identified with the extrinsic driver (increased diversity in the age of the stock). More diversity links to better recruitment. There is a trend of decrease in diversity in the age of the stock which links to lower recruitment over time. SSB is not a variable in the relationship but stock condition is inherent within the chosen variable of diversity in the age of the stock.	GAM: 24.6 B-H: 0.05_{NS} Ricker: 0.4_{NS}
Western Scotland Cod	R ~SSB + SST in April around Arran Or R ~ SSB + Cfin + s(SST)	Negative relationship with increasing sea surface temperature around a spawning ground in April. Recruitment is positively related with level of SSB The temperature in the region is consistently increasing, leading to a likely decrease in recruitment. The second model links *C. finmarchicus* abundance to recruitment. The relationship is, however, negative. Further research is required to elucidate the negative effect of this copepods' abundance on cod recruitment.	GAM:56 eB-H: 57 Ricker: 25.7 eRicker: $_{NS}$
Baltic cod	R~ SSB+ s(NAO) + s(reproductive volume in the Gotland Basin during May)	Positive relationship with SSB (despite recent indications that recruitment might be independent of SSB[1]). Negative to 0 winter NAO index values support high cod recruitment (apparently this variable is not a limiting factor). When the NAO index is in the positive phase values cod recruitment starts to decrease rapidly (negative relationship). The low reproductive volume in the Gotland Basin in May (up to the circa level 3) does not influence cod recruitment, but then it begins to be highly and positively correlated. The trend of the reproductive volume index is one of decrease (albeit it fairly variable). The NAO in the winter phase is generally positive with a tendency towards zero in recent years, perhaps leading to a negative flip. The positive phase of the NAO indicates that recruitment is favoured but this is offset by the fact that the phase is actually close to zero and that the reproductive volume is decreasing.	GAM:68.9 B-H: 36 Ricker: 35
North Sea Cod	R ~ s(SSB) + s(SST at Marsdiep Jan-June)	Increased temperature correlates with lower recruitment (negative relationship). SSB follows a comparable Ricker recruitment relationship (positive relationship blunting at high SSB). The temperature trend is one of increasing temperature but there is high degree of variability.	GAM: 70.15 B-H: 54.2 Ricker: 63

North Sea Plaice	R = s(NAO) + Temp in a feeding area + s(minimum temperature in a spawning area)	A positive effect of the NAO-index of the winter before spawning with a blunting effect at positive values of the NAO index. The temperature in the spawning area during spawning has a negative additive effect blunting at higher temperatures. There is weak trend of increasing temperature in the area, but the temperatures over time are highly variable. The results indicate a negative effect of the temperature in feeding area 2 on recruitment. Temperature in the feeding area appears to be increasing, while less variable than the spawning temperature profile, the trend is similarly weak. The NAO is in a low positive phase and the weak trends of increasing temperature in the species' important areas indicates that there may be a decrease in recruitment, but the observed trends are weak.	GAM: 55.13 B-H: 37.94 Ricker: 17.71
Hake	R ~ SSB +s(NAO)	The model shows a positive effect of the negative part of the NAO on hake recruitment and a negative additive relationship with a blunt effect at the positive part of the NAO. The NAO index, between -0.2 and 0, has a clear positive effect on recruitment. Trend is currently in the positive phase increasing likelihood of poor recruitment.	GAM: 81.1 B-H:57.8 eB-H:66.8 Ricker:57.2 eRicker:66.2

1. Horbowy (personal communication) suggests that from year 1987 onwards, the Eastern Baltic cod recruitment appears to be stock independent:

(key: NS = not significant; B-H = Beverton-Holt S-R equation; "e" prefix indicates that an extrinsic driver was also applied)

Table 2. The identified GAM relationships between recruitment variation and statistically derived metrics of the pelagic species.

Species	Relationship	Trend favourable of unfavourable	Variance explained by the models (R^2)
North Sea Herring autumn spawners	R ~ s(SSB)+s(bottom salinity around Orkney)	The North Sea Herring is thought to display different SSB-R type relationships pre- and post the 1978 stock collapse. Model described smoothers for the whole available data series encapsulating a range of different stock conditions. SSB: at low SSB the link with recruitment is positive; when SSB approaches an index of 1 there is a switch to a negative relationship which then reaches a stable state (there are only a few values for high SSB preventing interpretation). With salinity there is a similar positive relationship at lower salinity, around 35 ppt and above there is a negative relationship. In the spawning region, there is a general increase in salinity, but there is limited variability in the time series around the mean (s.d. 0.05). thus it is difficult to predict trend.	GAM: 46.4 B-H:21.97 Ricker: 22.13
Icelandic Herring summer spawners	R ~ Total egg production from repeat spawners + NAO winter index + temperature at Siglunes	The identified explanatory variables are positive. The NAO is currently in a positive phase. The general trend points to positive but flips to the negative intermittently can and do occur. The temperature in the region is also increasing. This favours better recruitment While absolute-SSB is not a variable, the condition of the adult stock contributing to recruitment is inherent within	GAM: 62.3 B-H: 32.5 Ricker: NS

		the 'total egg production' variable. The number of eggs from repeat spawners is thought to be increasing.	
Baltic Herring Gulf of Riga	R ~ SSB + Baltic Sea Index (dec-feb)	Positive relationship with BSI (atmosphere-ocean index). The current trend of the BSI shows a decrease with likely fall in recruitment.	GAM: 65 B-H: 24 Ricker: 40
Central Baltic herring	R ~ s(SSB) + sea surface temperature in august	Recruitment is positively related to SST and to SSB. A slight increase in temperature is observed favouring increased recruitment.	GAM: 59 B-H: 15.8 Ricker: 10.9
Baltic Sprat	R ~ SST (July-august)	SSB is not in the model. At SSB above 200 000 tonnes, recruitment is independent of density. Below 200 000 tonnes there is insufficient data to derive a relationship, but it is presumed to exist. There is a positive relationship with the temperature variable. There is a consistent increase in temperature in the index, thus recruitment should be improved.	GAM: 53 B-H: 1 Ricker: -6
Iberian Sardine	R ~ localSST + East Atlantic pattern + western Iberian upwelling index (4th Quarter)	There is a negative linear effect of the SST variable on the recruitment. There is a consistent upward trend in SST in the region implying reduced recruitment. Recruitment in relation to the Eastern Atlantic (EA) pattern (which is an atmosphere-ocean index) index is complex. There is a positive effect of intermediate values in the *EA* pattern anomalies on sardine recruitment and a negative additive effect of the extreme values of the *EA*. There is a consistent positive trend in the EA index – while currently intermediate the phase has recently been in the extreme state. The third component of the model shows a negative effect of weak upwelling conditions and that recruitment seem to be favored by the occurrence of southerlies (negative values of upwelling) or higher upwelling events. The current phase is positive with high values – therefore recruitment favoured (but the upwelling index is variable). SSB was excluded from the model selection – implying independence (within the tested ranges of SSBs). Generally poor outlook when variables are combined.	GAM: 50.8 Ricker: 33.3 eRicker: 46.7
Mediterranean Bluefin tuna	R ~ s(SSB) + s(SST anomaly in western Mediterranean waters) + s(NAO)	An anomaly index was used. The effect of the SST anomaly values, Western Mediterranean data, on the recruitment of the bluefin tuna is bell-shaped, with a critical point at 0 for the inversion of the recruitment tendency. In the negative phase (i.e. colder than normal) recruitment increases while decreases above average temperatures in July. The effect of the NAO is generally linear with recruitment increasing from between phases -2 to 2 (at the higher phases inferences cannot be made due to the small number of noted events). The current trend points to an increase in temperature with decrease in recruitment especially since bluefin tuna are very sensitive to temperature with respect to spawning. But the trend is very variable.	GAM: 72% Ricker: 12%

(key: NS = not significant; B-H = Beverton-Holt S-R equation; "e" prefix indicates that an extrinsic driver was also applied)

The derived S-Re GAM models, describing change in a biological process, needed to be used within a fisheries model to offer analyses of the effects of change in extrinsic drivers on stock population dynamics and how management can respond. To integrate knowledge of the effects of extrinsic drivers with management, INEXFISH chose to utilise a bio-economic simulation model of fisheries and ecological systems called Fisheries Library in R (FLR) (http://flr-project.org/doku.php). An advantage of adopting FLR is that it is thoroughly tested, understood and accepted by most major European fisheries institutes. The application of FLR in INEXFISH required that INEXFISH created an adjunct population dynamics model (Figure 3) that works with the current FLR model framework. This ultimately allows evaluation of the sensitivity of the management regimes to the selected extrinsic drivers.

The FLR population model was used, initially, to perform sensitivity analyses to determine how biological variation in biological processes affects population dynamics in the studied stocks.

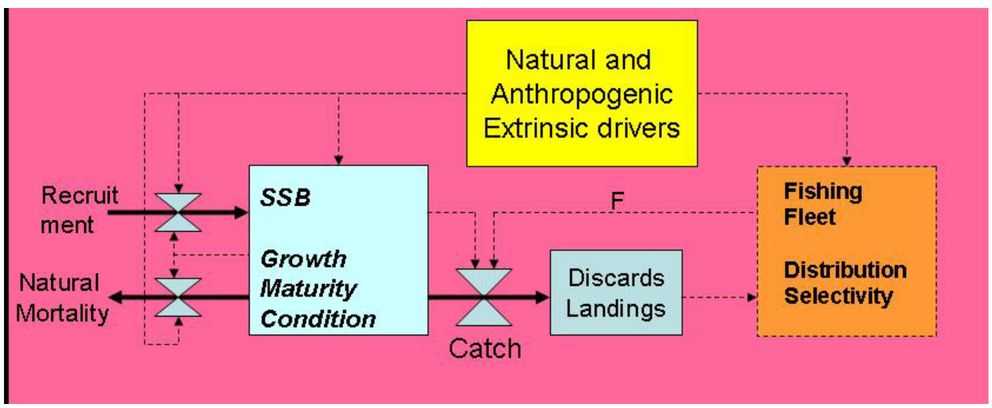

Figure 3. Schematic representation of the population dynamics model

Subsequently, the identified S-Re GAM models with the population model (integrated with FLR) allowed investigations of extrinsic driver /environmental and 'standard' harvest control rules.

A Harvest Control Rule is a "rule" used to control fisheries exploitation e.g. if there is a fall in the number of fish in the stock below a certain amount, the level of fishing should be reduced. There are many types of HCR and fishing is generally controlled by HCRs which relate to the status of the stock. INEXFISH looked at the effects of seven different HCRs under different environmental conditions, e.g. a sudden shift from poor to good environmental conditions for fish or a gradual trend leading to poor conditions.

Running model scenarios for different stocks (North Sea Cod, Herring and Plaice) led to the following conclusions: the environment may have a considerable impact on all of these stocks' spawning stock-recruitment dynamics. Changes in an unfavorable direction may lead to markedly lower yields with a higher variation over time and an increased chance of stock collapse. In the face of these risks a more precautionary exploitation strategy i.e. Fmsy reduction ameliorates or in most cases even negates these effects. At this time the GAM models and population model-FLR suite appear to perform more sensitively with respect to unfavourable conditions/stressed stocks.

In summary, when environmental conditions are poor for fish, the use of eHCRs may increase yields by over 10%. eHCRs provide better information to conserve stocks compared to simple stock based HCRs which have no consideration of the environment.

What is the next step?

As each stock responds to the different drivers in different ways, management becomes complicated and causes difficulties in implementation. A potential way to get around this is to examine scenarios based on the available models which then allow robust environmental Harvest Control Rules (eHCR) to be developed (Figure 4).

This would be a transparent and easy way to apply the complex models developed.

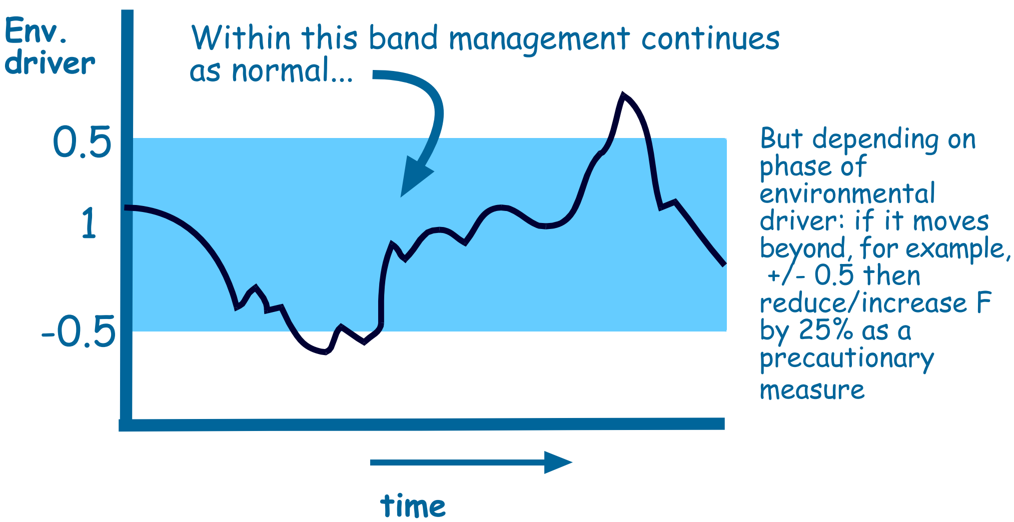

Figure 4. Event scenario fisheries management (schematic).

Specific policy recommendations arising from INEXFISH

1. ICES be tasked with developing an advisory framework that includes, via environmental Harvest Control Rules and modelling, consideration of extrinsic factors on stock dynamics. As a first step ICES needs to establish a Working Group to consider how the appropriate scenarios be formulated.
2. In due course, EC requests for advice from ICES specifically ask that the results be framed in terms of environmental Harvest Control Rules.
3. The EU Data Collection Regulation (DCR) (Council Reg. 199/2008, COM Reg. 665/2008, COM Reg. 1078/2008, and COM Dec. XXXX/2008 (not published yet)) should include extrinsic drivers.

   It is necessary to improve the knowledge base and coverage for:

- Phytoplankton-zooplankton -- fuller community composition
- Phytoplankton-zooplankton -- improved understanding of seasonal and spatial distribution (including bloom events).
- Data on natural predators on fish
- Data to better map spatial and stratification changes in hydrological condition
- Data on toxic substances provided that these have, or is likely to have, an impact on fish populations.

4. The organisations concerned for the collection of biological and extrinsic data should receive more support
5. Members of the EU should be made to comply with the present regulations.

If climate change is a reality, we are likely to be moving outside of the environmental regimes /extrinsic driver envelop which we have experienced historically and are described by the current data sets. Continuing and refining monitoring of extrinsic drivers and improving models which describe both the effect of extrinsic drivers on biological processes and how variation in biological parameters affect growth, maturity *et cetera* of organisms is needed.

Lessons from the INEXFISH project.

- Extrinsic drivers are important and influence fish population dynamics
- Of the 17 fisheries analysed by the S-Re General Additive Modelling approach and review:
  - All (100%) showed effects due to fishing
  - Most (94%) showed effects due to climate
  - Only large predators (swordfish, tuna) potentially showed a pollution effect
- The additive models produced are viable, and quantitatively increase understanding of fish population dynamics compared to classic models of Spawning Stock - Recruitment Relationships.

INEXFISH has produced

- A review on anthropogenic and non-anthropogenic drivers which effect the marine environment.
- Reviews on how drivers affect populations in RAC sensitive case study areas, and
- Identified where the research priorities lie to improve and further develop the INEXFISH tools and approaches.

- Frameworks to:
  - Assess metrics
  - Acquire data (including a developed software tool)
  - Apply a rigorous statistical framework to better understand how extrinsic drivers affect biological processes (based on General Additive Modelling)
  - Apply risk-uncertainty considerations to Spawning Stock-Recruitment relationships affected by known variation in extrinsic drivers.

- Population model associated with Fisheries Library in R which allows
  - Determination of the effect of biological variation on biological processes
  - Incorporation of extrinsic drivers into Spawning Stock-Recruitment relationships
  - Investigate the effects of different types harvest controls rules (HCRs)
    - Standard HCRs
    - Harvest Control Rules modified in response to change in extrinsic drivers (environmental -- eHCRs)

Intentions for use and impact

The fisheries management tools devised by INEXFISH aim to specifically improve scientific knowledge that can be used for the development of advice from the International Council for the Exploration of the Sea (ICES) and the Scientific Advisory Committee of the General Fisheries Commission for the Mediterranean (GFCM).

Photos
The participants at the first INEXFISH workshop hosted by the University of Liverpool

Back row: Michele Deflorio, Sture Hanson, Gregorio De Meterio, Louize Hill, Catherine L. Scott, Per Dolmer, Anders Bignert (invited expert: Swedish Museum of Natural History Contaminant Research Group) and Mrs. Ziro Suzuki.
Front row: Victoria de Zarate (invited expert: IEO, Santander Station), Fatima Borges, Gregory Beaugrand (invited expert: University of Lille), Olle Herne and Ziro Suzuki (invited expert: President of the Scientific Committee of ICCAT).

Project logo

Project public website: www.inexfish.org

All documents referred to in the text are available on the project website.

2. Dissemination and use.

Table 3 presents the material developed and submitted throughout the duration of INEXFISH by activity type (colour separated).

Table 3. Overview table of published work.

Date produced month	Type	Type of audience	Countries addressed	Size of audience	Partner **responsible** /involved.
Month 1 = Jan 2006					
6	Production of D1	scientific community and European Community	EC	n/a	**1**, 2,7,8,9
30	Production of D2	scientific community and European Community	Global	n/a	**8**, 1, 2, 3, 4, 5, 6, 7, 9
30	Production of D3, D4, D5, D6	Scientific community and European Community	Global	n/a	1,**2,4,6,7**
36	Production of D7	General public, scientific community and European Community	Global	n/a	**1**,2,3,4,5,6,7,8,9
27	Interim WP 3-6 case study reports (4 documents)	General public – selected stakeholders for review	EC	n/a	1, **2**, 3,**4**,5,**6**,**7**,8,9
12	Interim report	European Community	EC	n/a	**1**,2,3,4,5,6,7,8,9
18	Mid-term periodic report	European Community	EC	n/a	**1**, 2,3,4,5,6,7,8,9
36	Final report	General public, scientific community and European Community	Global	n/a	**1**,2,3,4,5,6,7,8,9
14	Conference	Scientific community	Global	n/a	**8**
16	Conference	Scientific community and general public	EC	n/a	**6,** 1, 8, 9
16	Conference	Scientific community and general public	EC	n/a	**2**
21	Conference Presentation	Scientific community	Global	200+	**9**
23	Conference	Scientific community	Baltic Sea region	30	**8, 6**
24	CLIOTOP Conference	Scientific community and general public	Global	200	**5**, 7
27	Conference paper and communication	Scientific community	Global	n/a	**2**
27	Conference, followed by paper	Scientific community and general public	Sweden	100	**8**
28	Conference	Scientific community and general public	Global	200	**5**, 7
28	Seminar	University scientists	Sweden	20	**8**
29	Conference	Science community	EC	n/a	**4**, 1
33	Conference paper and communication	Scientific community	Global	n/a	**2**
33	Conference paper and communication	Scientific community	Global	n/a	**9**
33	Conference	Scientific community and general public	Global	n/a	**6,** 1, 8, 9
33	Conference paper and communication	Scientific community and general public	Global	n/a	**1, 8**
36	Meeting SIBM (Italian Society of Marine Biology)	Scientific community	National	n/a	**7**
37	Conference	Scientific community and	Global	200	**9**

		general public			
42	Conference	Scientific community	Global	n/a	**6**, 1
25	Working group meeting	Scientific community	Iceland	15	**3**
20	Workshop	Scientific community	Baltic Sea region	30	**8**
37	Workshop	Scientific community	EC	30+	**1**
40	Workshop	Scientific community	EC	30+	**1**
18	Scientific paper	Scientific community	Global	n/a	**8**
18	Scientific paper	Scientific community	Global	n/a	**8**
18	Scientific paper and communication	Scientific community	Global	n/a	**9,** 6
30	Scientific poster	Scientific community	Global	n/a	**2**
30	Scientific paper	Scientific community	Global	n/a	**8**
31	Scientific paper	Scientific community	Global	n/s	**9, 6**
36	Scientific paper	Scientific community	Global	n/a	**3**
36	Scientific paper	Scientific community	Global	n/a	**5, 7**
36	Scientific paper	Scientific community	Global	n/a	**8**
37	Scientific paper	Scientific community	Global	n/a	**9**
6	Newsletter	scientific community and European Community	EC	n/a	**1**
6	Newsletter	General public and scientific community	Global	n/a	**1**
18	Newsletter	General public and scientific community	global	n/a	**1**
2	Press release	General public	EC	n/a	**1**
32	TV Interview	General Public	EC		**5**
35	Workshop presentation pack	Science and Stakeholder community	EC + Norway	20	**1,** 4, 5, 8.
37	Final summary brochure	General public, scientific community and European Community	Global	n/a	**1**,2,3,4,5,6,7,8,9
36	Policy Implementation Plan	European Community	EC	n/a	**1**,2,3,4,5,6,7,8,9
2	INEXFISH web site	General public and scientific community	Global	n/a	**1**

Copies and further details are available in the Final plan for using and disseminating the knowledge (Appendix).

Table 4 presents future scientific publications based on INEXFISH's outputs and includes the current status of the various scientific papers.

Table 4. INEXFISH future scientific publications

Title	Derived from WP	Status	Potential submission date 2009	Lead partner

Incorporating the effect of external drivers of stock dynamics into fisheries management	WP7 (and case studies)	In partner review	June	1
Evidence of climate impact on recruitment of hake, Nephrops and sardine in West Iberia- Portugal	WP5	In partner review	June	2
The effects of extrinsic factors on fish stocks: Improving understanding, detection and attribution of change in commercial fish stocks.	WP7 (and case studies)	Final draft	June	1
The sensitivity of fish population dynamics to biological variation: consequences for fisheries management	WP3 and WP7	Final draft	June	4
The use of extrinsic drivers in fishery management	WP7	Final draft	June	4
Incorporating risk-uncertainty into management – an INEXFISH approach	WP2	Penultimate draft	July-August	1
An analysis of NAO and temperature impacts on fish stocks	WP2	Penultimate draft	August	8
Review of anthropogenic and non-anthropogenic factors affecting fish stocks.	WP1	To be developed from WP1	August	1
Incorporating extrinsic drivers into the management of the Baltic cod, sprat, and herring stocks.	Wp4	Final draft	August	6
Review of anthropogenic and non-anthropogenic factors affecting the Mediterranean Sea.	WP1	Penultimate draft	September	7
Managing the ecosystem approach and finding environmental proxies for recruitment: North Sea herring	WP3	To be developed from WP3	Before the end of '09	4
Extrinsic drivers affecting NS plaice population dynamics	WP3	To be developed from WP3	Before the end of '09	4
Long Term management strategies to the recovery and conservation of Iberian hake including climate fluctuations.	WP5	To be developed from WP5	Before the end of '09	2