DEEPFISHMAN
Management and monitoring of deep-sea fisheries and stocks

EU FP7 project
grant No 227390

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Deepfishman

DEEPFISHMAN project

- 13 partners from 9 countries
- 3 millions Euros EC contribution
- April 2009 - September 2012

Case studies

Black scabbardfish (West Portugal)

Redfish (Iceland & Norwegian Sea)

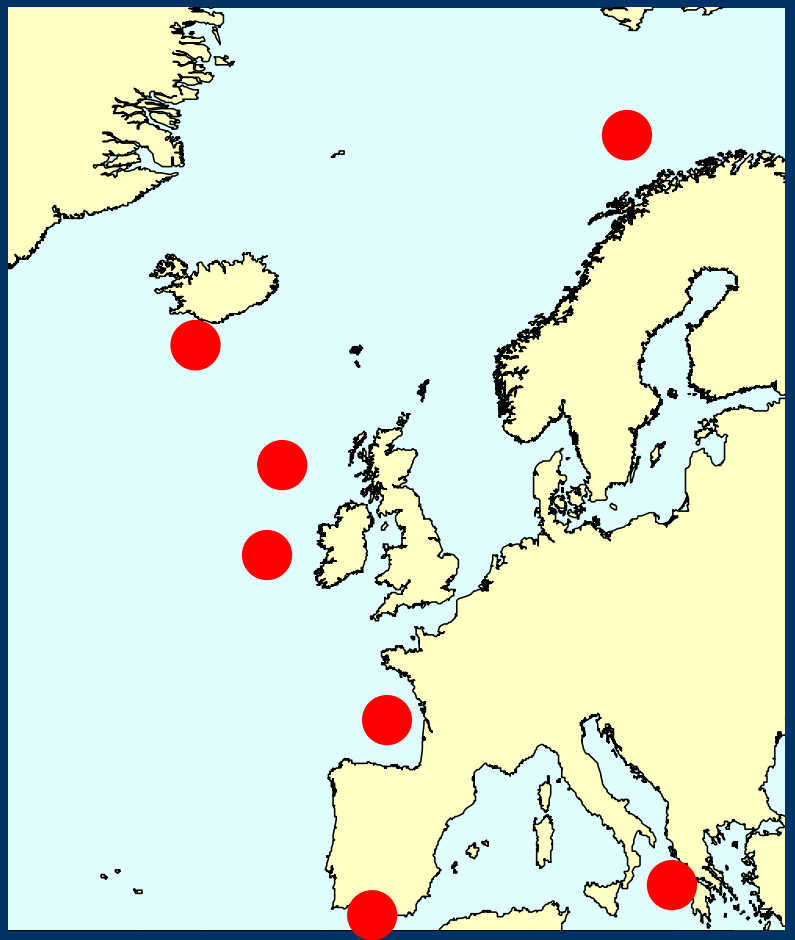
Greenland halibut (NAFO area)

Orange roughy (Namibia & Ireland)

Blue ling (West of BI)

Blackspot sea bream (Gibraltar, Bay of Biscay, Ionian Sea)

Mixed species trawl fishery (West of BI)



General aims

- Develop
  - Stock assessment methods
  - Biological reference points (BRPs)
  - Harvest control rules (HCRs)
  - Managements strategies
  - Monitoring requirements
- Account of
  - Stock sensitivity
  - Biodiversity/ecosystem and VMEs sustainability and conservation
  - Socio-economic profiles of fisheries
- Using
  - Experience in other areas
  - Case study data and knowledge
  - Stakeholder consultation

Areas of DEEPFISHMAN progress

- Economics of deep-water fisheries
- Definition of deep-water environment and species
- Definition of deep-water fishing effort, management implications of observed effort distribution
- Deep-water fish stock assessment methods
- Steps towards an ecosystem approach
- Monitoring and management framework
- Project publications
- Future research needs for deep-water fisheries, stocks and ecosystems

Economics of deep-water fisheries

Results of simulation modeling of deep-water fisheries

- Transferable fishing rights (ITQs) are more efficient for the management of deep-water fisheries

Results of stakeholder consultation

- Stakeholders are not in favour of ITQs
  - NGOs and small scale fishery sector fear the appropiation of resources by large companies
  - Large scale fishery sector thinks ITQs will not bring any change

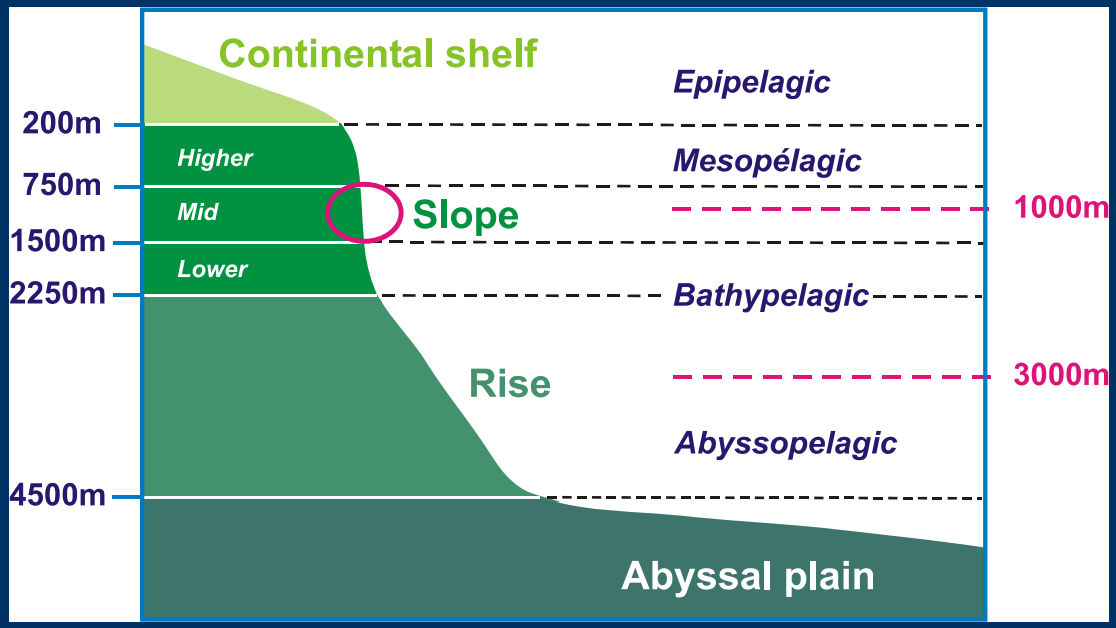
DEEPFISHMAN deliverables 3.2, 3.3 and 7.4

Agnarsson S. & Stefansson, A.S., (in prep.). Effective management of deep-sea species: The Icelandic redfish fishery in the Irminger Sea. Symposium Ecosystem based management and monitoring in the deep Med. & N. Atlantic, Galway, Ireland, August 28-31 2012.

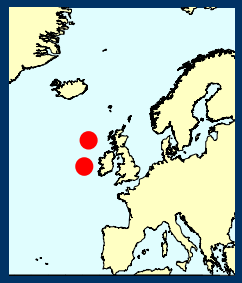
Definition of deep-water species and environments

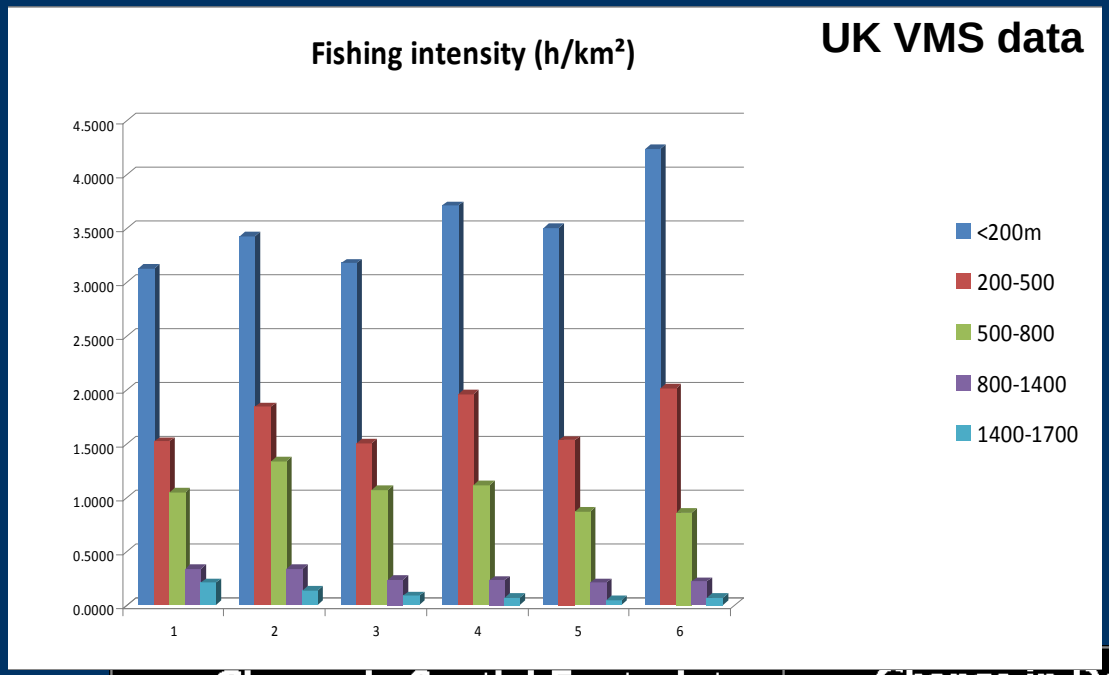
DEEPFISHMAN proposal

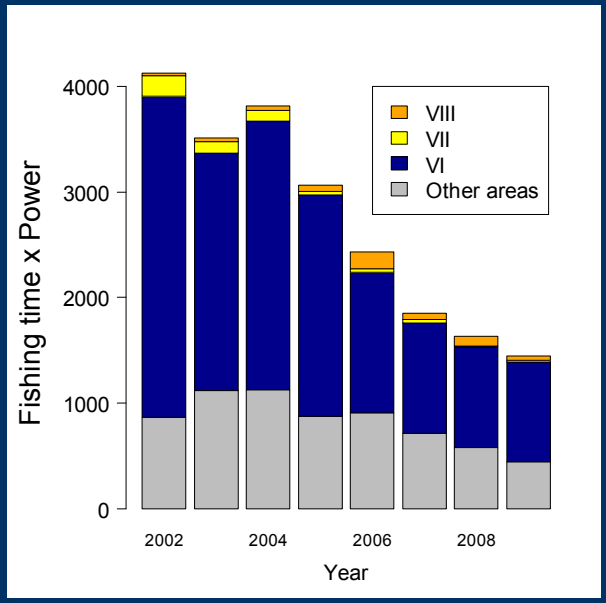
- Deep-water habitat: below 200 m
- Deep-water fish species: species with more than 50% of the biomass distributed deeper than 200 m
- EU vessel licensing: combination of annex I and II with some adjustment



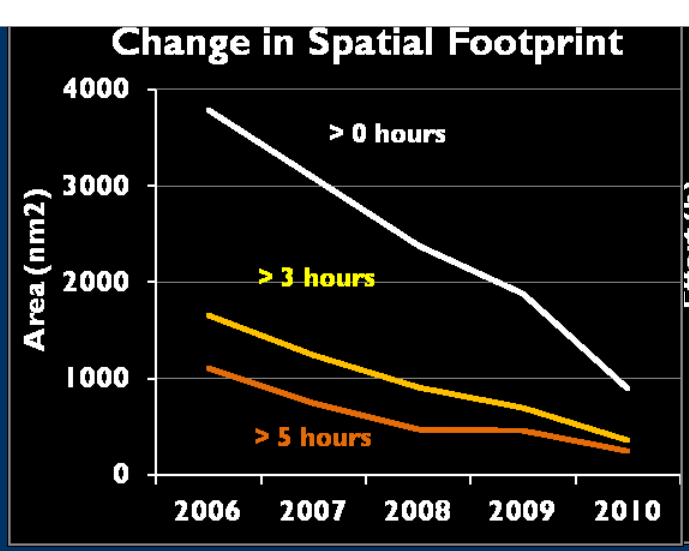
Definition of deep-water fishing effort

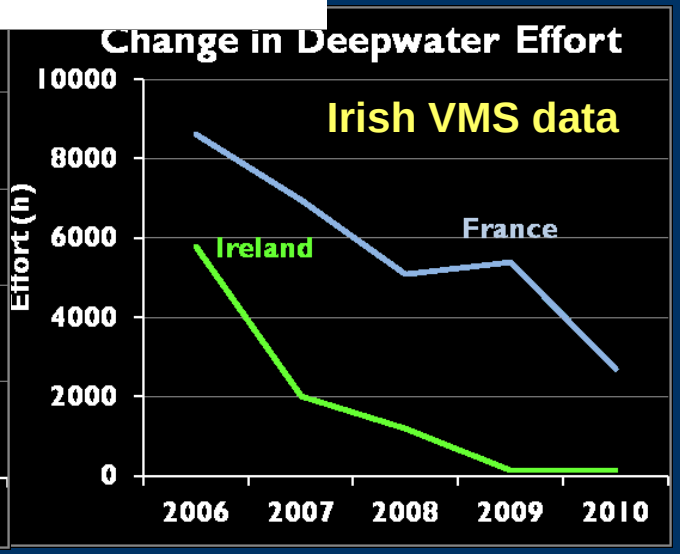




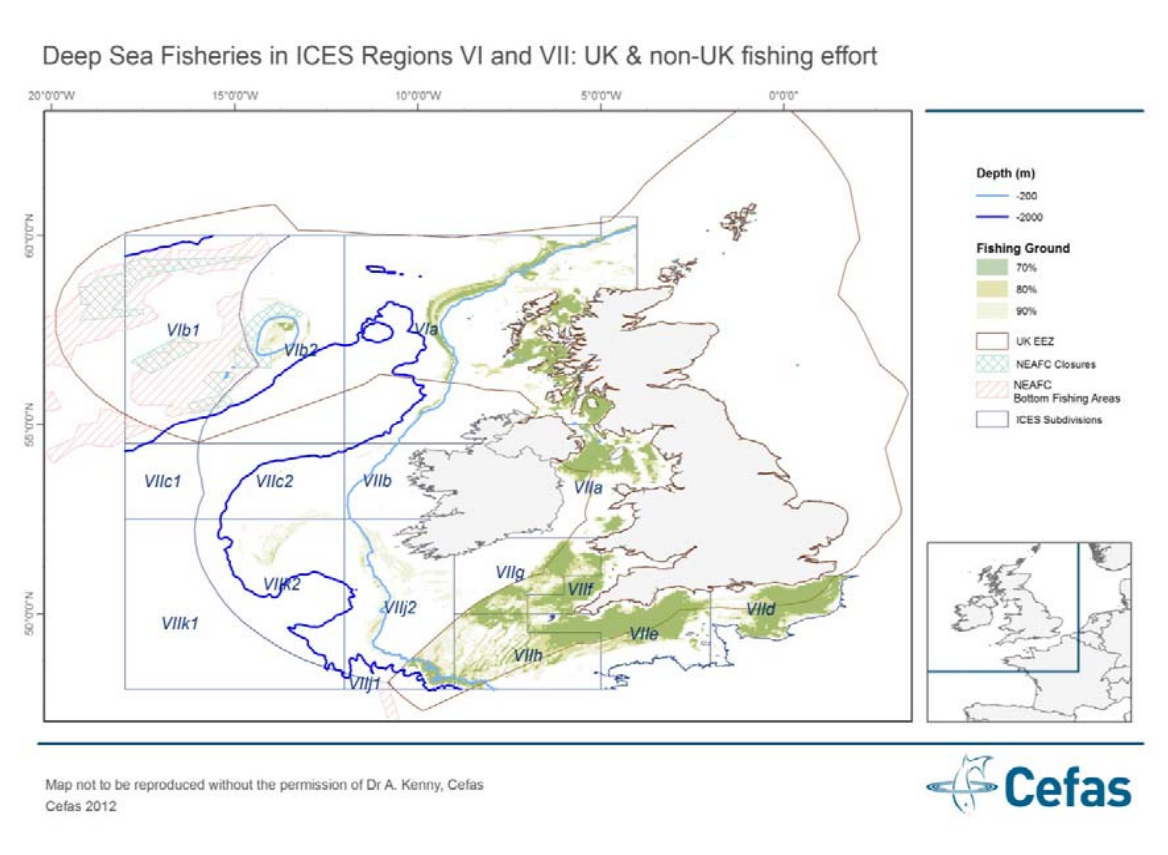


French deep-water fleet >800 m

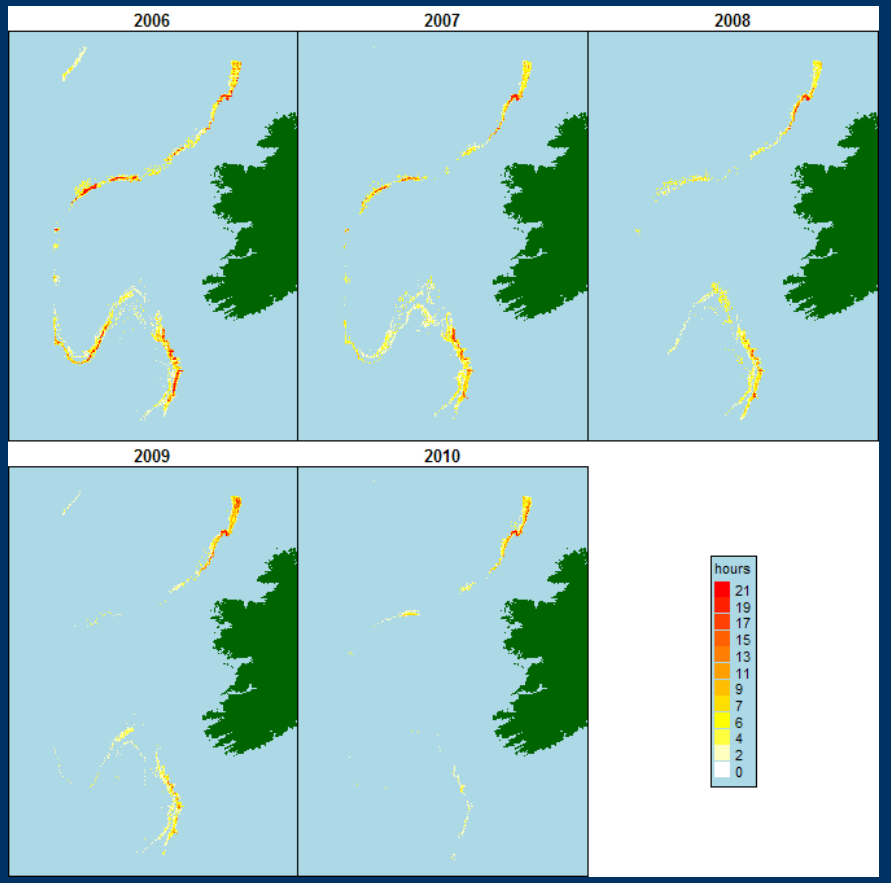




Spatial and temporal distribution of deep-water fishing from VMS



UK waters



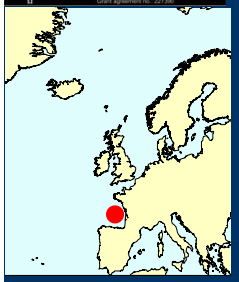
Irish waters

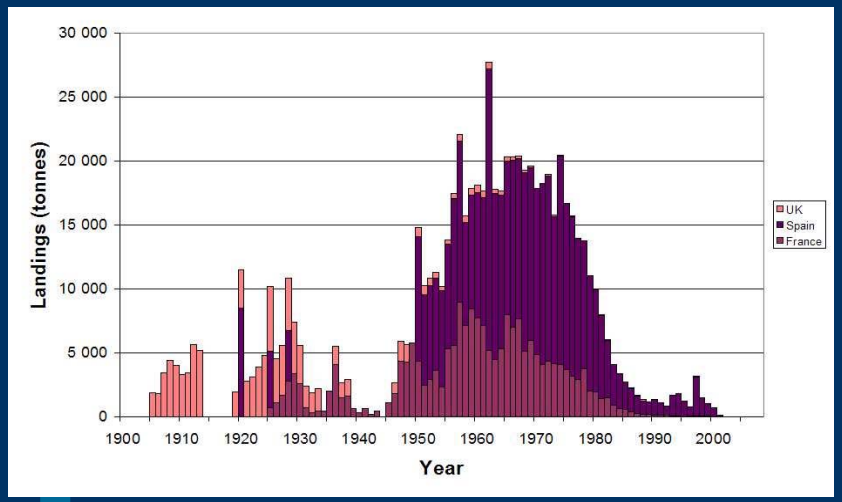
Deep-water fisheries

Deep-water fish stock assessments

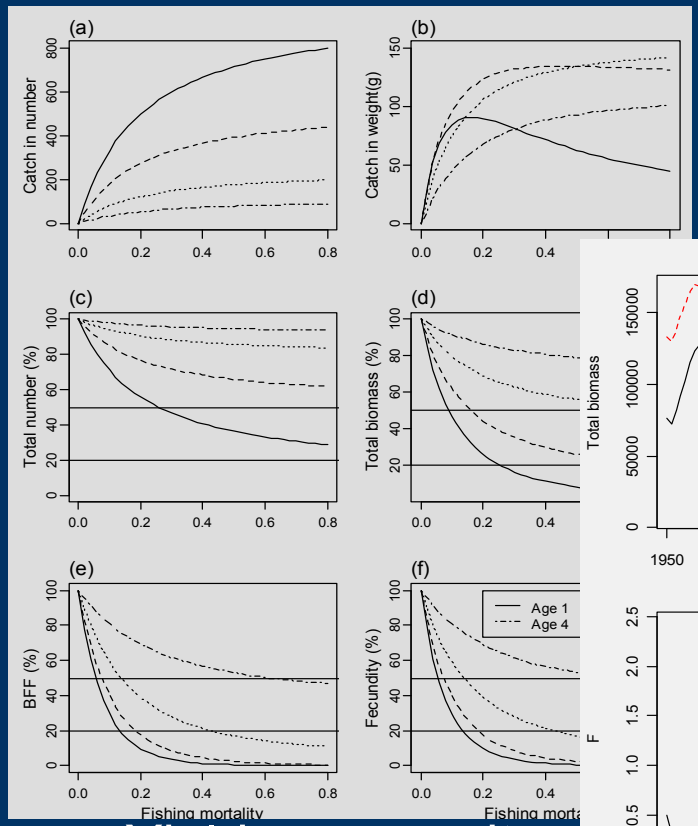
- Stock assessments are essential for PCP and MSFD to manage at MSY
- Challenging for data poor stocks
- Wide range of situations labelled « Data poor »
- Deep-water stocks not necessarily data-poor
- DEEPFISHMAN contribution: Data collation to improve stock diagnostics
- DEEPFISHMAN contribution: New assessment methods

Data collation
Red sea bream in the Bay of Biscay

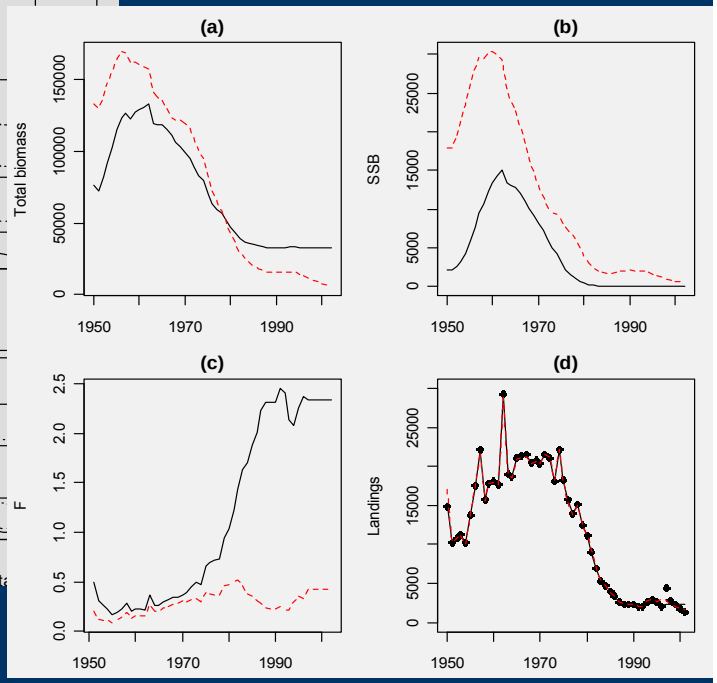




DEEPFISHMAN diagnostic



Yield per recruit

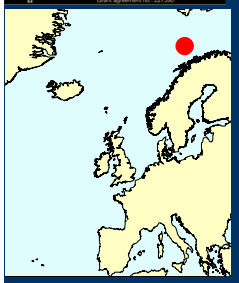


Population dynamics

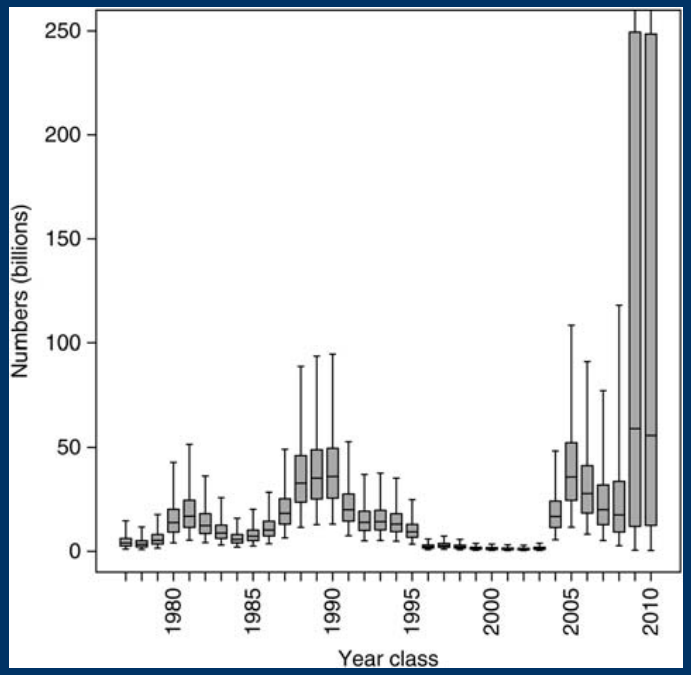
Depleted rather than data poor
State of stock clear: collapsed
Management can only aim at rebuilding; current management appropriate

Lorance, P. 2011. History and dynamics of the overexploitation of the blackspot sea bream (*Pagellus bogaraveo*) in the Bay of Biscay. ICES Journal of Marine Science, 68: 290-301.

Data collation
Reconstructing beaked redfish recruitment



Statistical model
- Numbers-at-age in the population and observation in 4 surveys
- Ages 0 to 15



Reconstructed time series of year-class strength

Model has been further developed for full stock assessment

Planque, B., Johannesen, E., Drevetnyak, K. V., and Nedreaas, K. H. 2012. Historical variations in the year-class strength of beaked redfish (*Sebastes mentella*) in the Barents Sea. ICES Journal of Marine Science, 69: 547-552.

DEEPFISHMAN new methods

Stock assessment methods

- Multi-annual year class curves (age based)
- Bayesian state space model of black scabbardfish and deep-sea sharks (two-stages)
- Bayesian production model for roundnose grenadier
- GADGET toolbox for Icelandic blue ling
- Simulation testing of new and traditional assessment methods for data poor situations

Indicator based assessment

- Standardizing CPUEs using GAMs
- Likelihood method for identifying joint time trends in multiple time series
- Spatial density modelling
- Spatial indicators
- Community level size-based indicators
- Productivity susceptibility Analysis (PSA) of orange roughy

Management

- Mono-specific Management Strategy Evaluation (MSE)
- Spatially explicit MSE
- Qualitative MSE
- Trade-off analysis

Multi-annual year class curves

Population dynamics model

- Abundance : $N_{a,t} = N_{a-1,t-1} \exp(- Z_{t-1})$ $1<a>A+$
- Recruitment: $N_{1,t} = R_t \sim \log N(\mu_R, \sigma_R^2)$
- Total mortality: $Z_t \sim N(Z_{t-1}, \sigma_Z^2)$
- Initial state: $N_{a,1} = \exp(a_r - a) Z0 \; R_{t-a+a_r}$

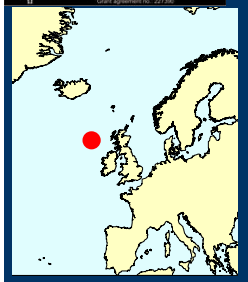
Observation model

- Proportions-at-age: $P_{a,t} \sim$ Multinom$(p_{a,t}, m_t)$
- Total catch: $C_t \sim$ Gamma(a,b)

$E[C_t] = (Z_t - M)/Z_t \; (1 - \exp(-Z_t)) \; N_t$

Trenkel et al., (in press). A random effects population dynamics model based on proportions-at-age and removal data for estimating total mortality *(Canadian Journal of Fisheries and Aquatic science)*

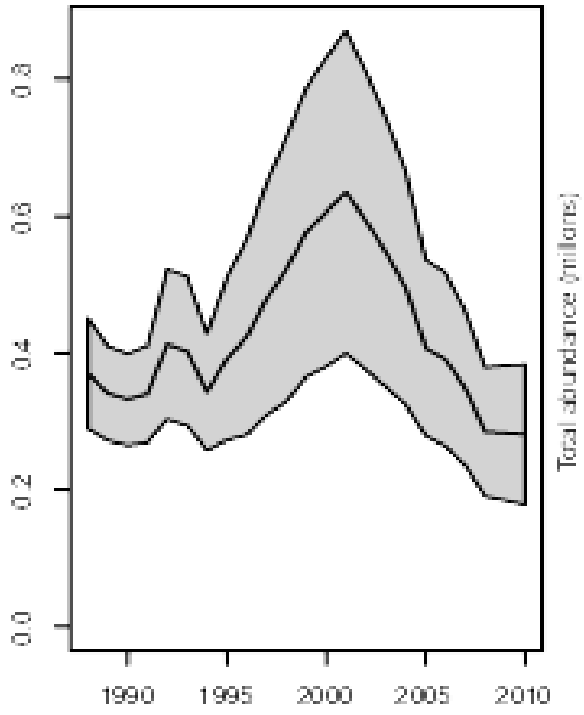
Application to blue ling



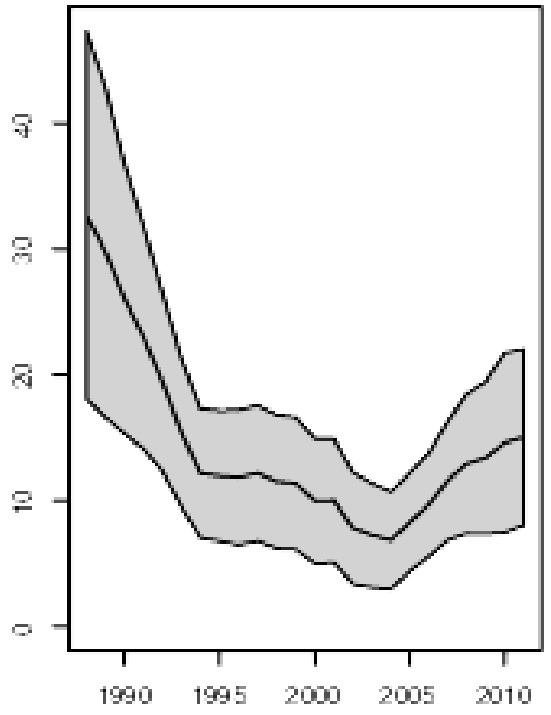
Data from commercial fishery

- Total catch (t) 1988 - 2011
- Numbers-at-length sample data (missing years)
- Age-length sample data (missing years)

Total mortality



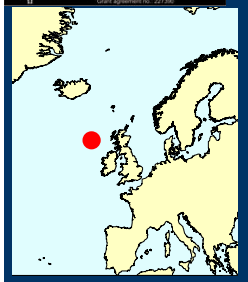
Abundance



Assumptions

- constant catchability ages 9 - 19+
- CV(catch) = 0.01

Spatial density modelling
Investigating spatial time trends: local depletion?

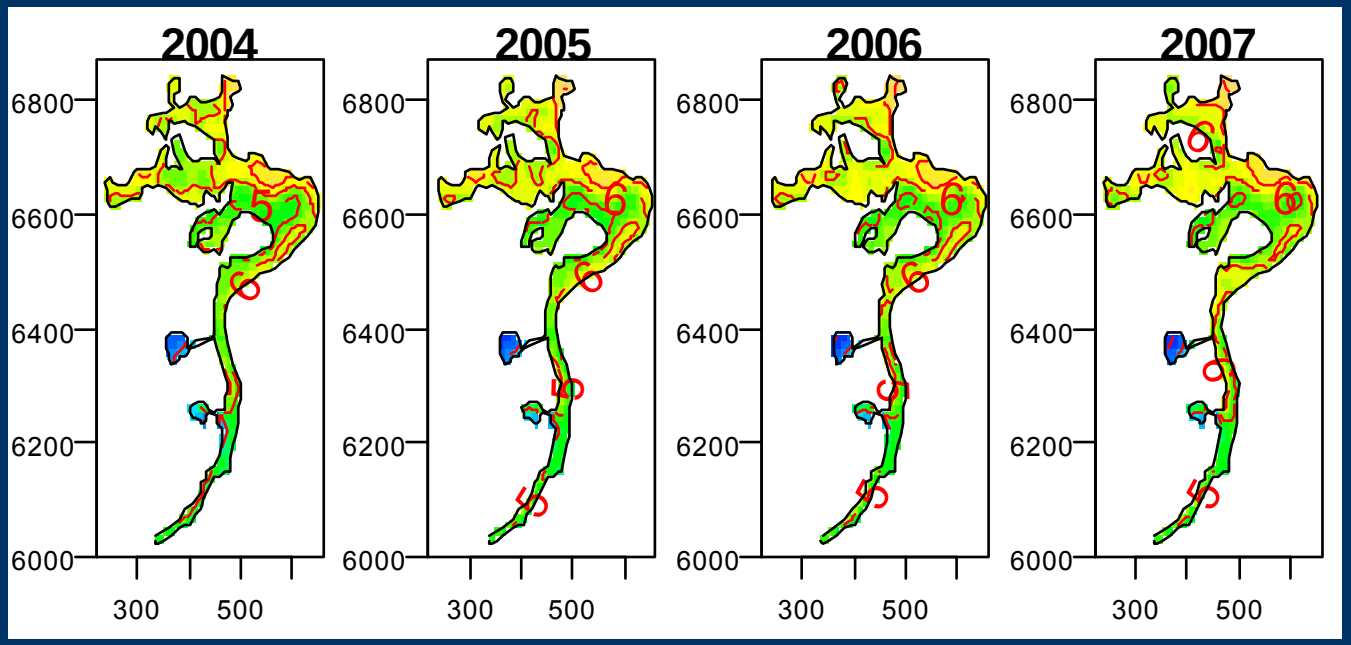


Model: landings per haul

log(E[landings]) = s(duration) + s(depth) + s(month) +
soap(eastings, northings, year) + s(depth,month) + s(depth, year)

3D soap smoother

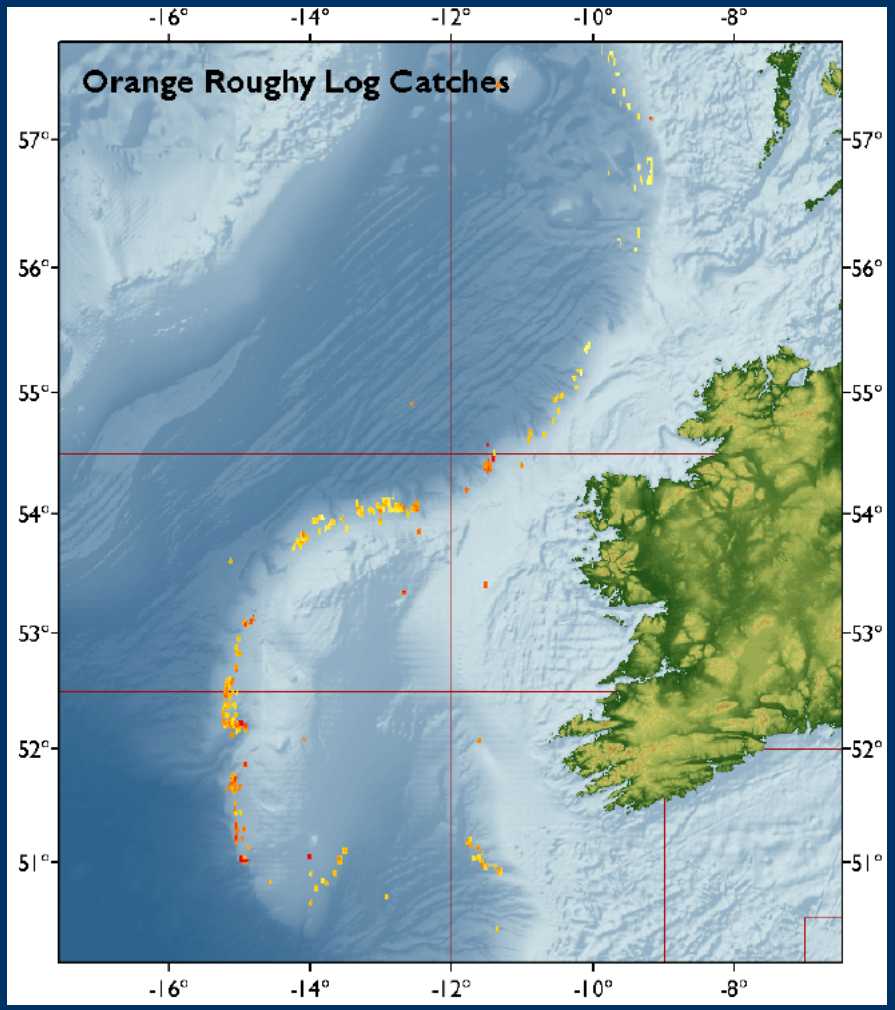
landings~Tweedie(μ, Φ $\mu^{1.5}$)



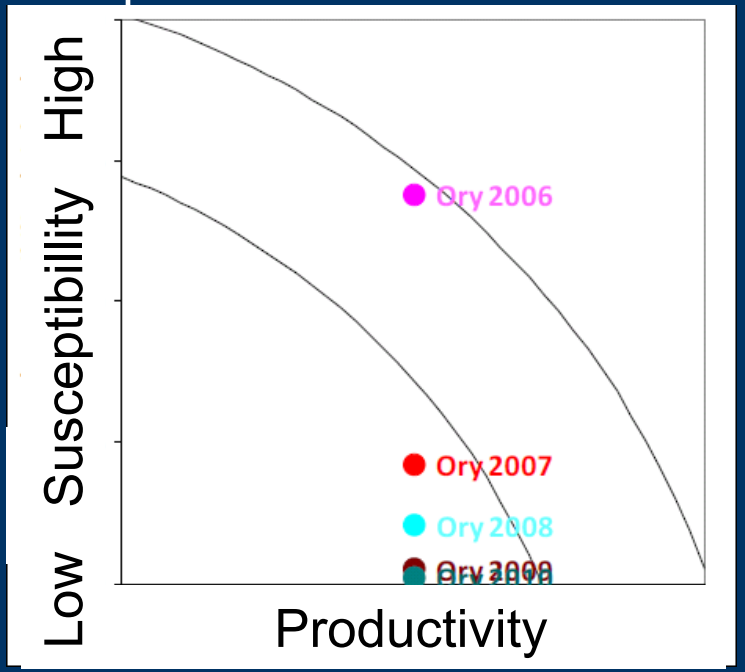
Blue ling

Augustin, N.H., Trenkel, V.M., Wood, N.S., Lorance, P. (under revision) Space-time modelling for blue ling using soap film smoothers. (Environmetrics)

Orange roughy
Productivity Susceptibility Analysis

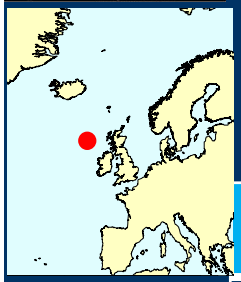


DATA
- 0n-board observations
- Personal log books
- Scientific surveys
- VMS data of the French and Irish Deepwater fisheries



Dransfeld, L, Hareide, NR, & Lorance, P. (in prep.) Managing the risk of vulnerable species exposure to deepwater trawl fisheries- The case of Orange Roughy to the west of Ireland and Britain. (DEEPFISHMAN Special Issue)

Trade-offs in blue ling fishery management objectives



Objective	Management measure	Trade-off
Exploit target stocks at MSY	TAC	Mixed fisheries
Protect vulnerable or depleted species	Ban sharks landings	
Prevent overfishing	Seasonal closure of spawning areas	Swept area Shark discards
Minimise the effect of bottom fishing on the seafloor	Sedimentary seafloor: None VMEs: spatial closure	Catch rates and benthic production

P. Lorance. (2012) Continental slope fisheries and conservation of vulnerable fish species and deep-water benthic communities: Implications for management (World Fisheries Conference, Edimburgh, Scotland, 7-11 May 2012

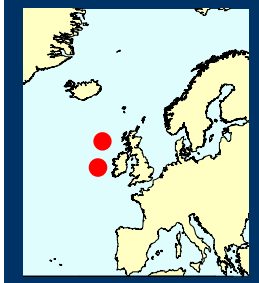
Summary of DEEPFISHMAN assessment methods

Method		Application test	Stock assessment
Multi-annual year class curves	**	Blue ling Roundnose grenadier	BLI West of B.I. (WGDEEP 2012)
State-space life-stage model	*	Black scabbardfish Deep-sea sharks	BSF (WGDEEP 2012)
Reconstructed time series of recruitment	**	Beaked redfish	RED (WKRED 2012; AFWG 2012)
Account of discards Bayesian production model	** *	Roundnose grenadier	RNG West of B.I. (WGDEEP)
Test of assessment methods	*	BLI, RNG, BSF, SBR	
GADGET toolbox		Icelandic blue ling	BLI Iceland (WGDEEP 2012)
Seasonal events in abundance	**	Greater forkbear	
Productivity susceptibility Analysis (PSA)	*	Orange roughy	
Standardizing CPUEs using GAMs	**	BLI, BSF, RNG	W. of B.I. (WGDEEP)
Likelihood method for identifying joint time trends in multiple time series	*	Blue ling, B. scabbardfish, R. grenadier sharks	
Spatial density modelling	**	Blue ling	
Community level size-based indicators	*	Deep-sea W of B.I.	

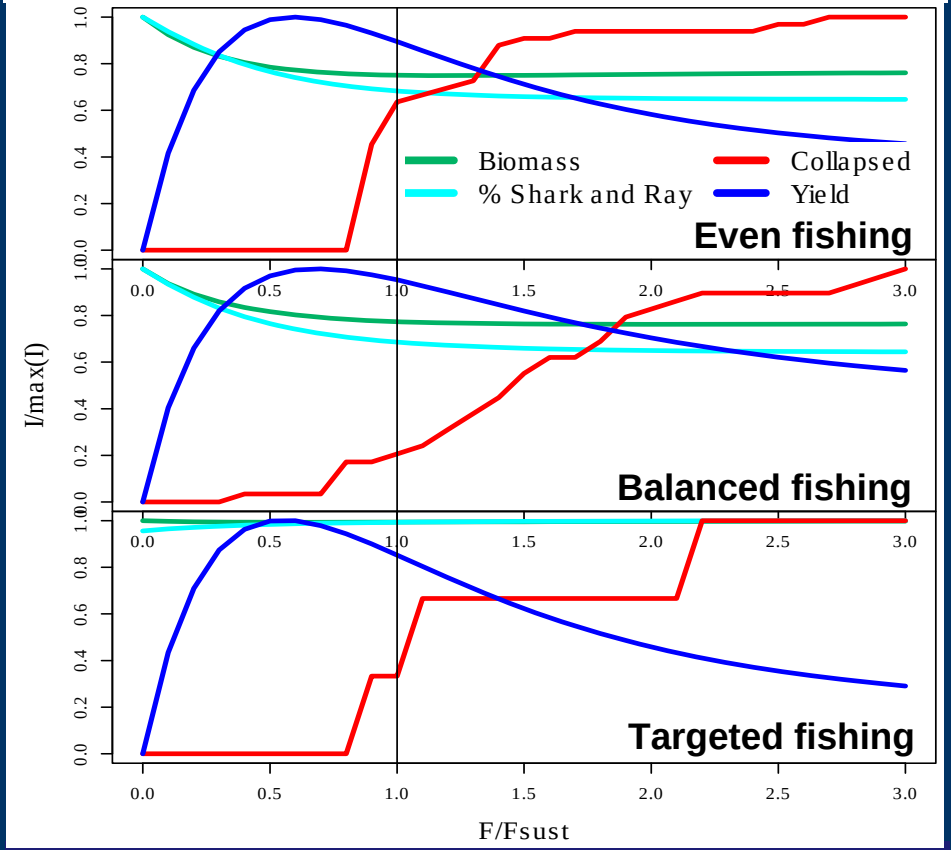
Conclusion of assessment methods

- Deep-water stocks are not all data-poor
- Several methods were developed or adapted for DEEPFISHMAN case studies: already used for ICES advice for 5 stocks
- DEEPFISHMAN assessment methods provide estimates of fishing mortality and absolute biomass for 4 stocks
- Spatial analysis complement stock assessment
- Survey data are not required by all assessment methods

Towards an ecosystem approach: multi-species sustainability indicators

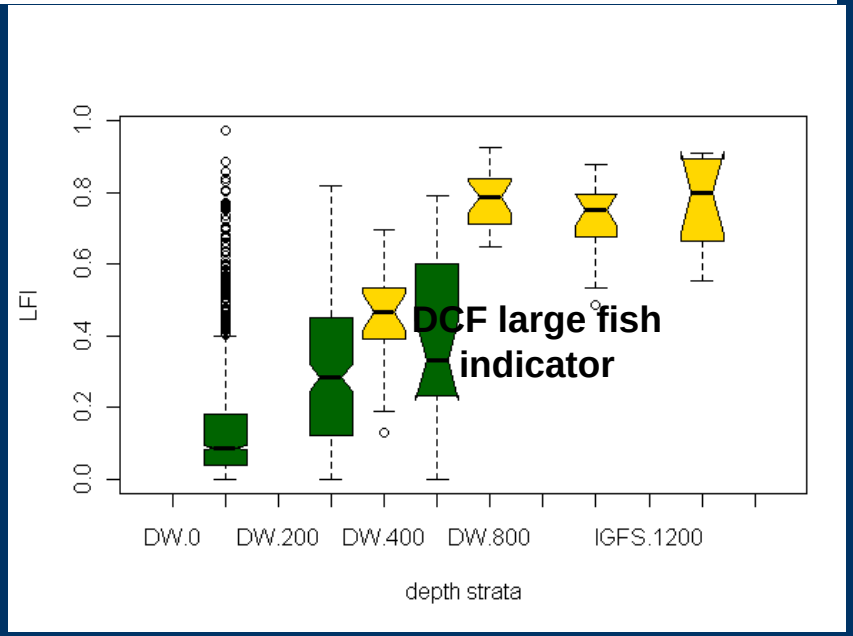


Community indicators under different fishing scenarios



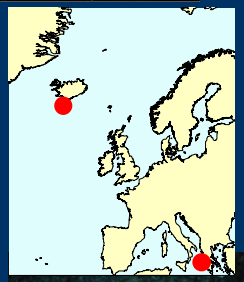
Blanchard, J.L., Trenkel, V.M., Scott, F., Lorance, P., (in prep.) Assessing the impacts of fisheries on deep-sea target and non-target species: insights from a trait-based multi-species model

Large fish Indicators from Irish IBTS and Deepwater surveys: increase with depth



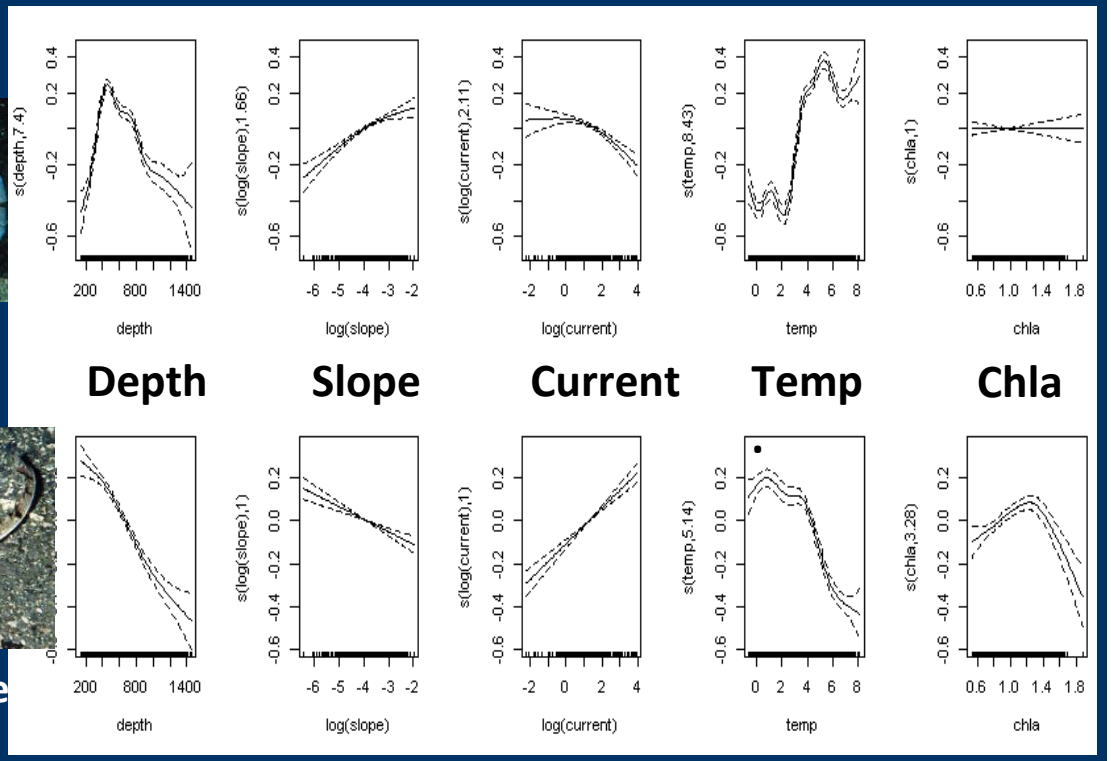
Dransfeld ,L., *et al.* (in prep.) Adapting ecosystem indicators to evaluate good environmental status to deepwater fish communities. (DEEPFISHMAN Special Issue)

Towards an ecosystem approach: understanding environmental effects

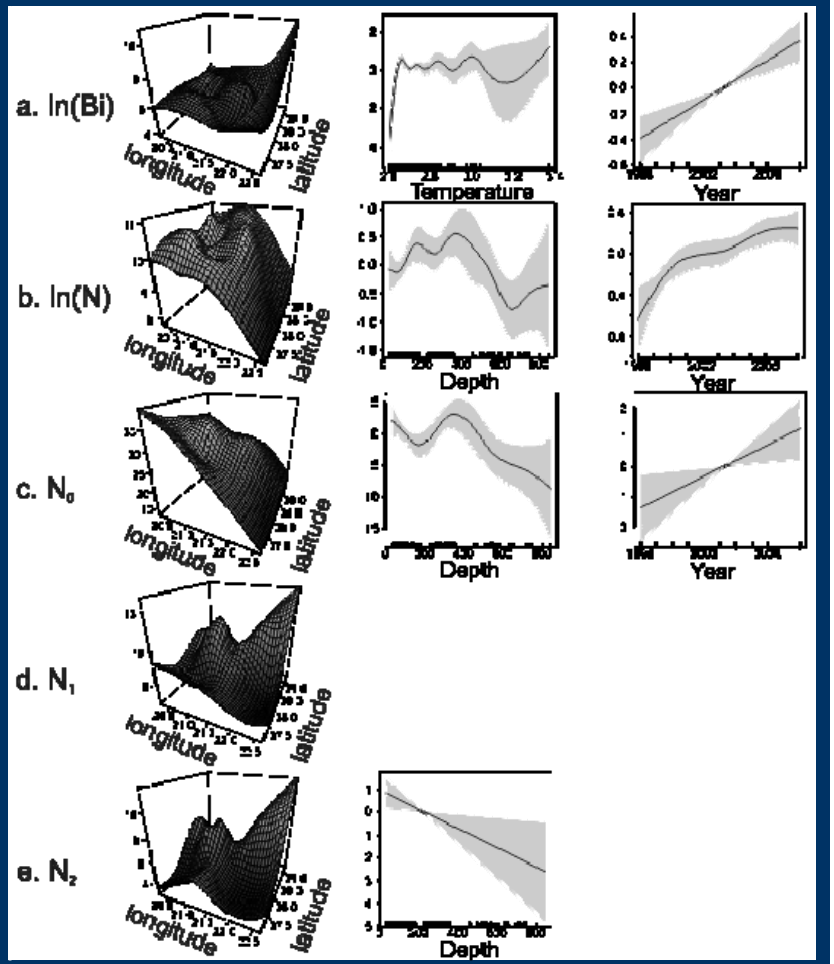


Deepwater redfish

Thorny skate



Roberts, *J. et al.* (in prep.) Fish diversity and environment: how do deep-water fish communities respond to abiotic gradients and are predictive models of species diversity useful for management? (DEEPFISHMAN Special Issue)



Tsagarakis K.*et al.* (submitted). Biodiversity, community and population indicators of the Ionian Sea demersal assemblages (Eastern Mediterranean): relation to environmental, spatial, temporal and fisheries factors and management implications, (*ICES journal of Marine Science)*

Stakeholder process in DEEPFISHMAN

- Workshop in Brussels, 29-30 June 2009
  - DEEPFISHMAN stakeholder identification
  - SWOT analysis of existing management measures
- Workshop in Lisbon, 4 December 2009
  - Cognitive maps of case study fisheries
- Workshop in Lisbon, 4 July 2011
  - Stakeholder contribution to model development
- Questionnaires
- Haul-by-haul catch and effort data provided by stakeholders
- Final workshop, 31 August 2012, NUIG, Galway, Ireland (with CoralFISH)
  - Presentation of the management and monitoring framework to stakeholders

Management and monitoring framework

Approach

A review analysis in 20 topics
Some quantitative analyses
Stakeholder consultation

Selected topics of the monitoring and management framework

- For licensing purposes the species listed in Annex I and II of 2347/2002 be combined, that *Conger conger, Lepidopus caudatus and Sebastes viviparus* be deleted and Greenland halibut, tusk and beaked redfish be included

- Harmonization of the NEAFC and EU lists of species

Selected topics of the monitoring and management framework

- The list of species managed by TACs may need to be expanded. However, for species landed in small quantities a concept of precautionary TAC is currently lacking

Some species that may be considered are:

Common mora (*Mora moro*) ;
Rabbitfish (*Chimaera monstrosa* and *Hydrolagus* spp);
Baird's smoothhead (*Alepocephalus bairdii*);
Wreckfish (*Polyprion americanus*);
Bluemouth (Blackbelly rosefish) (*Helicolenus dactylopterus*);
Black (deep-water) cardinal fish (*Epigonus telescopus*);
Deep-water red crab (*Chaceon* (*Geryon*) *affinis*)

- The periodicity of TAC revision could be expanded for some species

orange roughy: every 5 years
deep-water sharks: every 5 years
roundnose grenadier: every 3 years
beaked redfish: every 3 years
all other deep water species: every 2 years

Selected topics of the monitoring and management framework

- Scientific surveys are useful for species not landed (e.g. sharks). The ICES proposals for fishery independent surveys for the NE Atlantic deep water stocks be adopted by the new DCF

- In some fisheries haul-by-haul data were shown highly useful to produce abundance indices

- For the need of fisheries and stocks assessment, deep-water fishing intensity to be estimated from VMS

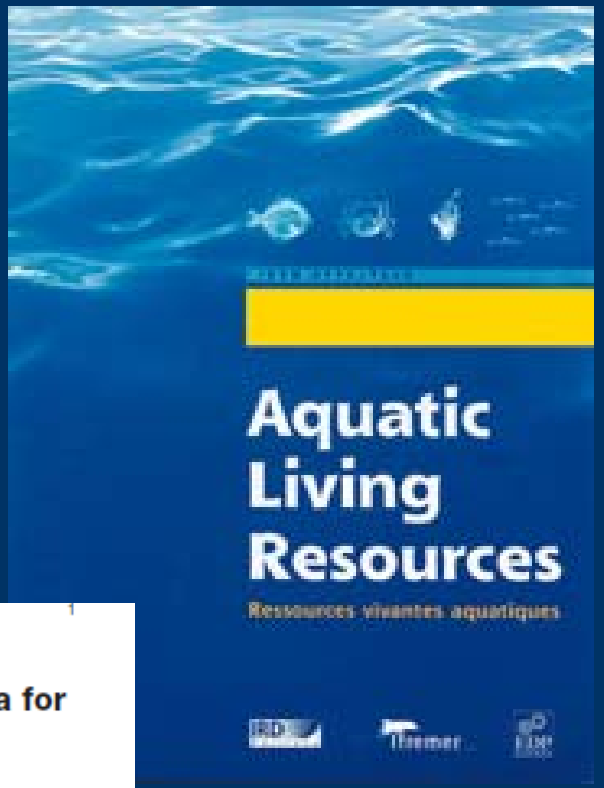
- Appropriate VMS data should be made available

Publications

8 published papers

4 papers under revison/submitted

Special issue in preparation

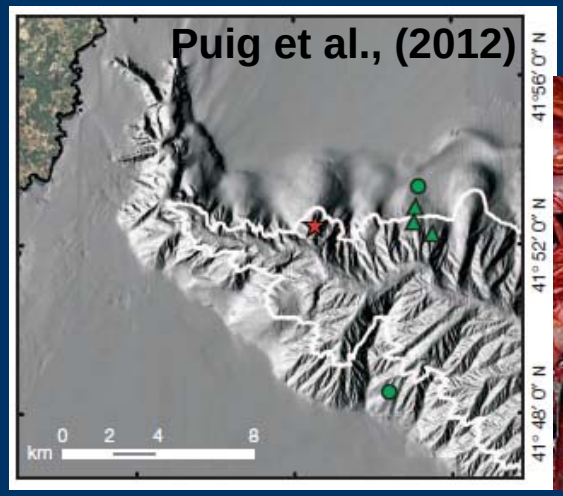


Future research needs

Ecosystem impacts and seafood production

Food supply chain analysis
Compare deep-water fisheries:
- Environmental impacts
- Energy intensity
- Economic efficiency

to other seafood productions (capture and aquaculture)



Mediterranean blue and red deep-sea shrimp:
-impact on bottom habitat

Tropical shrimp ponds:
- impact on mangrove

Future research needs

- Spatial data repository for VMEs and fishing ground (VMS data) distributions (need for an internationally coordinated data system) -FAO database-

- Ecosystem management taking account of trade-offs, e.g. between conservation and fishery management

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Exploit target stocks at MSY	TAC	Mixed fisheries
Protect vulnerable or depleted species	Ban sharks landings	
Prevent overfishing	Seasonal closure of spawning areas	Swept area Shark discards
Minimise the effect of bottom fishing on the seafloor	Sedimentary seafloor: None VMEs: spatial closure	Catch rates and benthic production

Acknowledgements

- Presentation uses material from all DEEPFISHMAN partners and the stakeholder consultation process
- Thanks to stakeholders contributing to workshops and responding to questionnaires
- Project material on http://deepfishman.hafro.is/