ICES WKLIFE2 REPORT 2012

ICES ADVISORY COMMITTEE

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Report of The Workshop to Finalize the ICES Data-limited Stock (DLS) Methodologies Documentation in an Operational Form for the 2013 Advice Season and to make Recommendations on Target Categories for Data-limited Stocks (WKLIFE II)

20-22 November 2012

Copenhagen, Denmark

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Executive summary

The assessment of stocks with either limited knowledge of their biology or lack of data on their exploitation levels has become increasingly problematic for ICES. Cognisant of this weakness in the current ICES advice, this second workshop was convened by ACOM to finalize the ICES data-limited stock (DLS) guidance document for the 2013 advice season and to consider further developing methodologies for DLS.

The **Workshop to finalize the ICES' Data-Limited Stock (DLS) methodologies documentation in an operational form for the 2013 advice season and to make recommendations on target categories for data-limited stocks** [WKLIFE II], chaired by Carl O'Brien (UK) and Manuela Azevedo (Portugal) met at ICES HQ, 20–22 November 2012 to:

a) Produce the DLS guidance document for the 2013 advice season by:

- i) Further developing the ICES DLS methodologies that were developed by WGLIFE 2012 and utilized in the 2012 Advice, and augment with omitted methodologies where appropriate;
- ii) Providing supporting documentation, in the form of simulations or published sources, for each of the methods-identifying any necessary future simulations;
- iii) Identifying prioritized required simulations. Although the results may not be available until late 2013, this should not limit the use of the guidance document for the 2013 advice;
- iv) Clearly stating for each method when precautionary measures (e.g. uncertainty caps, precautionary buffers) should be applied;
- v) For each method, outlining when the advice should be reopened in the future (e.g. every year vs. every five years).

b) Recommend target categories for each of the data-limited stocks for which ICES gave advice in 2012.

- i) Identify the data needed to be collected for the stocks for which ICES gave advice in 2012 in order to implement the approach described under a);
- ii) These recommendations will be made available for the December 2012 ACOM meeting and subsequently, presented to the January 2013 WGCHAIRS meeting.

c) Draft a proposal for consideration by ACOM on the stocks to be reassessed in 2013 for advice on fishing opportunities in 2014.

d) Draft Terms of Reference (ToRs) for WKLIFE III to focus on the development of quantitative assessment methodologies based on life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks.

These Terms of Reference (ToRs) were all addressed in this workshop and further guidance was provided for ACOM on DLS methodologies. The participants at WKLIFE II discussed the utility of PSA (Productivity and Susceptibility Analysis) in the context of stocks for which ICES provides advice and agreed that the susceptibility criteria need to be re-examined before becoming operational. This should be undertaken as part of the third and final meeting of WKLIFE III proposed for late 2013.

1 Introduction

1.1 Terms of reference

The **Workshop to finalize the ICES' Data-Limited Stock (DLS) methodologies documentation in an operational form for the 2013 advice season and to make recommendations on target categories for data-limited stocks** (WKLIFE II), chaired by Carl O'Brien (UK) and Manuela Azevedo (Portugal) will meet at ICES HQ, 20–22 November 2012 to:

a) Produce the DLS guidance document for the 2013 advice season by:

  i) Further developing the ICES DLS methodologies that were developed by WGLIFE 2012 and utilized in the 2012 Advice, and augment with omitted methodologies where appropriate;

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  iii) Identifying prioritized required simulations. Although the results may not be available until late 2013, this should not limit the use of the guidance document for the 2013 advice;

  iv) Clearly stating for each method when precautionary measures (e.g. uncertainty caps, precautionary buffers) should be applied; and

  v) For each method, outlining when the advice should be reopened in the future (e.g. every year vs. every five years).

b) Recommend target categories for each of the data-limited stocks in Table 1.1.1.

  i) Identify the data needed to be collected for the stocks in Table 1.1.1 in order to implement the approach described under a); and

  ii) These recommendations will be made available for the December 2012 ACOM meeting and subsequently, presented to the January 2013 WGCHAIRS meeting.

c) Draft a proposal for consideration by ACOM on the stocks to be reassessed in 2013 for advice on fishing opportunities in 2014.

d) Draft Terms of Reference (ToRs) for WKLIFE III to focus on the development of quantitative assessment methodologies based on life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks.

Table 1.1.1. Compilation of data-limited stocks for which the DLS category/methodology was used in 2012.

Stock	Stock name	EcoRegion	WG
guq-nea	Leafscale gulper shark in the Northeast Atlantic	Wide	WGEF
agn-nea	Angel shark in the Northeast Atlantic	Wide	WGEF
syc-bisc & syc-8c9a	Lesser-spotted dogfish in Biscay and Iberia	Bay of Biscay and Atlantic Iberian waters	WGEF
syc-celt	Lesser-spotted dogfish in the Celtic Seas	Celtic Sea and West of Scotland	WGEF
scy-347d	Lesser-spotted dogfish in the North Sea	North Sea	WGEF
trk-nea	Smoothhounds in the Northeast Atlantic	Wide	WGEF
alf-comb	Alfonsinos/Golden eye perch (*Beryx* spp.) in the Northeast Atlantic	Wide	WGDEEP
ane-pore	Anchovy in Division IXa	Bay of Biscay and Atlantic Iberian waters	WGHANSA
ang-78ab	Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Divisions VIIb–k and VIIIa,b,d	Celtic Sea and West of Scotland	WGHMM
ang-ivvi	Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Division IIIa, and Subareas IV and VI	Celtic Sea and West of Scotland	WGCSE
bsf-oth	Black scabbardfish (*Aphanopus carbo*) in other areas (Subareas I, II, IV, X, XIV, and Divisions IIIa and Va)	Wide	WGDEEP
bsf-89	Black scabbardfish (*Aphanopus carbo*) in Subareas VIII and IX	Wide	WGDEEP
bsf-nrtn	Black scabbardfish (*Aphanopus carbo*) in Subareas VI, VII, and Divisions Vb and XIIb	Wide	WGDEEP
bll-2232	Brill in Subdivisions 22–32 (Baltic Sea)	Baltic	WGBFAS
bll-nsea	Brill in Subarea IV and Divisions IIIa and VIId,e	North Sea	WGNEW
bli-5b67	Blue ling (*Molva dypterygia*) in Division Vb and Subareas VI and VII	Wide	WGDEEP
bli-oth	Blue ling (*Molva dypterygia*) in Divisions IIIa and Iva, and Subareas I, II, VIII, IX, and XII	Wide	WGDEEP
bli-5a14	Blue ling (*Molva dypterygia*) in Division Va and Subarea XIV (Iceland and Reykjanes ridge)	Wide	WGDEEP
boc-nea	Boarfish in the Northeast Atlantic	Wide	WGWIDE
bsk-nea	Basking shark in the Northeast Atlantic	Wide	WGEF
bss-comb	European Sea bass in the Northeast Atlantic	Wide	WGNEW
cod-coas	Cod in Subareas I and II (Norwegian coastal waters cod)	Barents Sea and Norwegian Sea	AFWG
cod-farb	Cod in Subdivision Vb2 (Faroe Bank)	Faroe Plateau Ecosystem	NWWG
cod-ingr	Inshore cod in NAFO Subarea 1 (Greenland cod)	Iceland and East Greenland	NWWG
cod-offgr	Offshore cod in ICES Subarea XIV and NAFO Subarea 1 (Greenland cod)	Iceland and East Greenland	NWWG

Stock	Stock name	EcoRegion	WG
cod-rock	Cod in Division VIb (Rockall)	Celtic Sea and West of Scotland	WGCSE
dab-2232	Dab in Subdivisions 22–32 (Baltic Sea)	Baltic	WGBFAS
dab-nsea	Dab in Subarea IV and Division IIIa	North Sea	WGNEW
Demersal elasmobranchs in the North Sea	Demersal Elasmobranchs Demersal elasmobranchs in the North Sea, Skagerrak, and Eastern Channel	North Sea	WGEF
dgs-nea	Spurdog in the Northeast Atlantic	Wide	WGEF
fle-2232	Flounder in Subdivisions 22–32 (Baltic Sea)	Baltic	WGBFAS
fle-nsea	Flounder in Division IIIa and Subarea IV	North Sea	WGNEW
gfb-comb	Greater forkbeard (*Phycis blennoides*) in the Northeast Atlantic	Wide	WGDEEP
arg-icel	Greater silver smelt (*Argentina silus*) in Division Va	Wide	WGDEEP
arg-oth	Greater silver smelt (*Argentina silus*) in Subareas I, II, IV, VI, VII, VIII, IX, X, XII, and XIV, and Divisions IIIa and Vb (other areas)	Wide	WGDEEP
gug-347d	Grey gurnard in Subarea IV (North Sea) and Divisions VIId (Eastern Channel) and IIIa (Skagerrak–Kattegat)	North Sea	WGNEW
gug-89a	Grey gurnard in Subarea VIII and Division IXa	Bay of Biscay and Atlantic Iberian waters	WGNEW
gug-celt	Grey gurnard in Subarea VI and Divisions VIIa–c and e–k (Celtic Sea and West of Scotland)	Celtic Sea and West of Scotland	WGNEW
gur-comb	Red gurnard in the Northeast Atlantic	Wide	WGNEW
had-7b–k	Haddock in Divisions VIIb–k	Celtic Sea and West of Scotland	WGCSE
had-iris	Haddock in Division VIIa (Irish Sea)	Celtic Sea and West of Scotland	WGCSE
her-31	Herring in Subdivision 31 (Bothnian Bay)	Baltic	WGBFAS
her-irlw	Herring in Divisions VIa (South) and VIIb,c	Celtic Sea and West of Scotland	HAWG
her-nirs	Herring in Division VIIa North of 52º30’N (Irish Sea)	Celtic Sea and West of Scotland	HAWG
hom-nsea	Horse mackerel (*Trachurus trachurus*) in Divisions IIIa, IVb,c, and VIId (North Sea stock)	North Sea	WGWIDE
jaa-10	Blue jack mackerel (*Trachurus picturatus*) in Subdivision Xa2 (Azores)	Bay of Biscay and Atlantic Iberian waters	WGHANSA
gug-nea	Leafscale gulper shark (*Centrophorus squamosus*) in the Northeast Atlantic	Wide	WGEF
lem-nsea	Lemon sole in Subarea IV and Divisions IIIa and VIId	North Sea	WGNEW
lin-icel	Ling (*Molva molva*) in Division Va	Wide	WGDEEP
lin-faro	Ling (*Molva molva*) in Division Vb	Wide	WGDEEP

Stock	Stock name	EcoRegion	WG
lin-oth	Ling (*Molva molva*) in Divisions IIIa and IVa, and in Subareas VI, VII, VIII, IX, XII, and XIV (other areas)	Wide	WGDEEP
lin-arct	Ling (*Molva molva*) in Subareas I and II	Wide	WGDEEP
meg-4a6a	Megrim (*Lepidorhombus* spp.) in Divisions IVa and Via	Celtic Sea and West of Scotland	WGCSE
meg-rock	Megrim (*Lepidorhombus* spp) in ICES Division VIb (Rockall)	Celtic Sea and West of Scotland	
mgw-78	Megrim (*Lepidorhombus whiffiagonis*) in Divisions VIIb–k and VIIIa,b,d	Celtic Sea and West of Scotland	WGHMM
mix-nsea	Mixed-fisheries advice	North Sea	WGMIXFISH
mut-347d	Striped red mullet in Subarea IV (North Sea) and Divisions VIId (Eastern English Channel) and IIIa (Skagerrak–Kattegat)	North Sea	WGNEW
mut-west	Striped red mullet in Subarea VI, VIII and Divisions VIIa-c, e–k and IXa (Western area)	Wide	WGNEW
nep-5	*Nephrops* in Botney Gut–Silver Pit (FU 5)	North Sea	WGNSSK
nep-10	*Nephrops* in Noup (FU 10)	North Sea	WGNSSK
nep-32	*Nephrops* in the Norwegian Deep (FU 32)	North Sea	WGNSSK
nep-33	*Nephrops* off Horn's Reef (FU 33)	North Sea	WGNSSK
nep-34	*Nephrops* in Devil's Hole (FU 34)	North Sea	WGNSSK
nep-2829	*Nephrops* in Southwest and South Portugal (FUs 28–29)	Bay of Biscay and Atlantic Iberian waters	WGHMM
nep-30	*Nephrops* in the Gulf of Cadiz (FU 30)	Bay of Biscay and Atlantic Iberian waters	WGHMM
nep-2627	*Nephrops* in West Galicia and North Portugal (FUs 26–27)	Bay of Biscay and Atlantic Iberian waters	WGHMM
neph-VIIIab	*Nephrops* in in Division VIIIab (Bay of Biscay, FUs 23–24)	Bay of Biscay and Atlantic Iberian waters	WGHMM
neph-VIIIc	*Nephrops* in North Galicia (FU 25)	Bay of Biscay and Atlantic Iberian waters	WGHMM
nep-31	*Nephrops* in the Cantabrian Sea (FU 31)	Bay of Biscay and Atlantic Iberian waters	WGHMM
nep-19	*Nephrops* off the southeast and southwest coasts of Ireland (FU 19)	Celtic Sea and West of Scotland	WGCSE
nep-16	*Nephrops* on Porcupine Bank (FU 16)	Celtic Sea and West of Scotland	WGCSE
nep-2021	*Nephrops* in the FU 20–21 (Labadie, Baltimore, Jones and Cockburn)	Celtic Sea and West of Scotland	WGCSE
nop-scow	Norway pout in Division VIa	Celtic Sea and West of Scotland	WGCSE
ory-comb	Orange roughy (*Hoplostethus atlanticus*) in the Northeast Atlantic	Wide	WGDEEP
pand-flad	Northern shrimp (*Pandalus borealis*) in Division IVa (Fladen Ground)	North Sea	WGNIPAG

Stock	Stock name	EcoRegion	WG
pand-sknd	Northern shrimp (*Pandalus borealis*) in Divisions IIIa and IVa East (Skagerrak and Norwegian Deep)	North Sea	WGNIPAG
ple-2123	Plaice in Subdivisions 21, 22, and 23 (Kattegat, Belts, and Sound)	Baltic	WGNSSK
ple-2432	Plaice in Subdivisions 24–32 (Baltic Sea)	Baltic	WGBFAS
ple-7b–c	Plaice in Divisions VIIb,c (West of Ireland)	Celtic Sea and West of Scotland	WGCSE
ple-7h–k	Plaice in Divisions VIIh–k (Southwest of Ireland)	Celtic Sea and West of Scotland	WGCSE
ple-89a	Plaice in Subarea VIII and Division IXa	Bay of Biscay and Atlantic Iberian waters	WGHMM
ple-celt	Plaice in Divisions VIIf,g (Celtic Sea)	Celtic Sea and West of Scotland	WGCSE
ple-eche	Plaice in Division VIId (Eastern Channel)	North Sea	WGNSSK
ple-iris	Plaice in Division VIIa (Irish Sea)	Celtic Sea and West of Scotland	WGCSE
ple-skag	Plaice in Subdivision 20 (Skagerrak)	North Sea	WGNSSK
pol-89a	Pollack (*Pollachius pollachius*) in Subarea VIII and Division IXa	Bay of Biscay and Atlantic Iberian waters	WGNEW
pol-celt	Pollack in Subareas VI and VII (Celtic Sea and West of Scotland)	Celtic Sea and West of Scotland	WGNEW
Pol-nsea	Pollack in Subarea IV and Division IIIa	North Sea	WGNSSK
por-nea	Porbeagle in the Northeast Atlantic	Wide	WGEF
cyo-nea	Portuguese dogfish in the Northeast Atlantic	Wide	WGEF
sbr-ix	Red (=blackspot) sea bream (*Pagellus bogaraveo*) in Subarea IX	Wide	WGDEEP
sbr-x	Red (=blackspot) sea bream (*Pagellus bogaraveo*) in Subarea X (Azores region)	Wide	WGDEEP
sbr-678	Red (=blackspot) sea bream (*Pagellus bogaraveo*) in Subareas VI, VII, and VIII	Wide	WGDEEP
rng-oth	Roundnose grenadier (*Coryphaenoides rupestris*) in all other areas (Subareas I, II, IV, VIII, and IX, Division XIVa, and Subdivisions Va2 and XIVb2)	Wide	WGDEEP
rng-kask	Roundnose grenadier (*Coryphaenoides rupestris*) in Division IIIa	Wide	WGDEEP
rng-1012	Roundnose grenadier (*Coryphaenoides rupestris*) on the Mid-Atlantic Ridge (Divisions Xb and XIIc, and Subdivisions Va1, XIIa1, and XIVb1)	Wide	WGDEEP
rng-5b67	Roundnose grenadier (*Coryphaenoides rupestris*) in Subareas VI and VII, and Divisions Vb and XIIb	Wide	WGDEEP
sal-32	Salmon in Subdivision 32 (Gulf of Finland)	Baltic	WGBAST
san-ns4	Sandeel in the Central Western North Sea (SA 4)	North Sea	WGNSSK
san-ns5	Sandeel in Division IIIa and Subarea IV	North Sea	WGNSSK
san-ns6	Sandeel in Division IIIa East (Kattegat, SA 6)	North Sea	WGNSSK
san-ns7	Sandeel in the Shetland area (SA 7)	North Sea	WGNSSK

Stock	Stock name	EcoRegion	WG
san-scow	Sandeel in Division VIa	Celtic Sea and West of Scotland	WGCSE
sck-nea	Kitefin shark in the Northeast Atlantic	Wide	WGEF
smn-arct	Beaked redfish (*Sebastes mentella*) in Subareas I and II	Barents Sea and Norwegian Sea	AFWG
smn-con	Beaked redfish (*Sebastes mentella*) in Division Va and Subarea XIV (Icelandic slope stock)	Iceland and East Greenland	NWWG
smn-dp	Beaked redfish (*Sebastes mentella*) in Subareas V, XII, and XIV and NAFO Subareas 1+2 (Deep pelagic stock >500 m)	Iceland and East Greenland	NWWG
smn-grl	Beaked redfish (*Sebastes mentella*) in Division XIVb (Demersal)	Iceland and East Greenland	NWWG
smn-sp	Beaked redfish (*Sebastes mentella*) in Subareas V, XII, and XIV and NAFO Subareas 1+2 (Shallow pelagic stock < 500 m)	Iceland and East Greenland	NWWG
smr-5614	Golden redfish (*Sebastes marinus*) in Subareas V, VI, XII, and XIV	Iceland and East Greenland	NWWG
smr-arct	Golden redfish (*Sebastes marinus*) in Subareas I and II	Barents Sea and Norwegian Sea	AFWG
sol-7b–c	Sole in Divisions VIIb,c (West of Ireland)	Celtic Sea and West of Scotland	WGCSE
sol-7h–k	Sole in Divisions VIIh–k	Celtic Sea and West of Scotland	WGCSE
sol-8c9a	Sole in Divisions VIIIc and IXa	Bay of Biscay and Atlantic Iberian waters	WGHMM
spr-celt	Sprat in Subarea VI and Divisions VIIa–c and f–k (Celtic Sea and West of Scotland)	Celtic Sea and West of Scotland	HAWG
spr-ech	Sprat in Divisions VIId,e	Celtic Sea and West of Scotland	HAWG
spr-kask	Sprat in Division IIIa (Skagerrak-Kattegat)	North Sea	HAWG
spr-nsea	Sprat in Subarea IV (North Sea)	North Sea	HAWG
trt-bal	Sea trout in Subdivisions 22–32 (Baltic Sea)	Baltic	WGBAST
tur-2232	Turbot in Subdivisions 22–32 (Baltic Sea)	Baltic	WGBFAS
tur-nsea	Turbot in Subarea IV and Division IIIa	North Sea	WGNEW
usk-mar	Tusk (*Brosme brosme*) in Subarea XII, excluding Division XIIb (Mid-Atlantic Ridge)	Wide	WGDEEP
usk-oth	Tusk (*Brosme brosme*) in Divisions IIIa, Vb, VIa, and XIIb, and Subareas IV, VII, VIII, and IX (other areas)	Wide	WGDEEP
usk-rock	Tusk (*Brosme brosme*) in Division VIb (Rockall)	Wide	WGDEEP
usk-arct	Tusk (*Brosme brosme*) in Subareas I and II (Arctic)	Wide	WGDEEP
whg-7e–k	Whiting in Divisions VIIe–k	Celtic Sea and West of Scotland	WGCSE
whg-89a	Whiting in Subarea VIII and Division IXa	Bay of Biscay and Atlantic Iberian waters	WGHMM
whg-iris	Whiting in Division VIIa (Irish Sea)	Celtic Sea and West of Scotland	WGCSE
whg-kask	Whiting in Division IIIa (Skagerrak–Kattegat)	North Sea	WGNSSK

STOCK	STOCK NAME	ECOREGION	WG
whg-rock	Whiting in Division VIb (Rockall)	Celtic Sea and West of Scotland	WGCSE
whg-scow	Whiting in Division VIa (West of Scotland)	Celtic Sea and West of Scotland	WGCSE
wit-nsea	Witch in Subarea IV and Divisions IIIa and VIId	North Sea	WGNEW

1.2 Background

This second workshop follows on from the initial February 2012 meeting held in Lisbon (ICES CM 2012/ACOM:36).

1.3 Conduct of the meeting

The workshop participants were divided into two subgroups during the meeting: a methods subgroup that considered proxies for the estimation of relative fishing mortality when biomass is not known, and an advisory subgroup that reviewed ICES' assessments and advice for DLS as implemented in 2012.

1.4 Structure of the report

The structure of the report is as follows:

- Section 2 deals with DLS methodologies, simulations and target categories for stocks;
- Section 3 deals with guidance on DLS to be reassessed in 2013, Productivity and Susceptibility Analysis (PSA) and length-based reference points; and
- Section 4 deals with discussions and conclusions.

1.5 Follow-up process within ICES

One recommendation is made to the ICES WGMG for follow-up work on the robustness of the ICES DLS approach, two recommendations to ACOM; together with draft ToRs for a third and final meeting WKLIFE III to be held in November 2013. These are summarized in Annex B and Section 4.1.1, respectively.

2 Data-limited stock methodologies

2.1 Utilized by ACOM in 2012

2.1.1 Data-limited stock guidance document

In 2010, ICES provided advice for 78 individual fish stocks, such as cod, plaice and sole. This year in 2012 ICES has, for the first time, expanded its scope to include quantitative advice on so-called *data-limited* fish stocks, such as flounder, brill and pollack. The process to define a method for providing this kind of advice began in 2011, and of the 84 data-limited stocks ICES considered in spring 2012, there is now quantitative advice for 68 of these stocks; further stocks were assessed during the remainder of 2012. This represents a six fold increase in quantitative advice provided for data-limited stocks compared to 2010, where such advice was only provided for 10 data-limited stocks. This new approach intends to aid policy-makers move towards sustainable exploitation of fisheries.

This new method developed by ICES, for providing operational advice on data-limited stocks, should help to ensure that fisheries on these stocks can be conducted sustainably. In many situations it is possible to judge the status of a fish stock and to quantify the upper limits of sustainable fishing quotas on the basis of biological information regarding the sensitivity of these species to fisheries and trends in their abundance as observed from research vessels. ICES considers that providing upper limits to fishing based on this newly developed method will be the best basis for responsible decisions on fishing opportunities. The advice includes an increasing precautionary margin with decreasing knowledge of the stock status.

Several workshops and review groups within the ICES' community have been held in an effort to develop quantitative advice for data-limited stocks and to document the methods. The WKFRAME III, WKLIFE, and RGLIFE provided guidance for determining quantitative catch advice for a range of situations from data-rich to data-limited stock assessments. However, when implementing the RGLIFE approach, ICES found that many data-limited stocks have less data and proxies than the RGLIFE methods required. Therefore, in an attempt to move towards being able to provide quantitative advice for as many data-limited stocks as possible, ICES has implemented a series of methods from WKLIFE, RGLIFE, WKFRAME III, and from Expert Groups with some caveats where necessary. These methods are intended to derive quantitative catch advice and to apply more precaution in more uncertain situations.

The draft document used during the 2012 advice season was reviewed and updated during the WKLIFE II meeting and a final document produced (ICES CM 2012/ACOM:68).

2.2 Simulations

2.2.1 Prioritization

The guidance document (ICES CM 2012/ACOM:68) referred to in Section 2.1 was used as the basis for deciding upon the prioritization of the simulations to be undertaken in 2013 before the third and final meeting of WKLIFE.

The Table 2.2.1.1 summarizes the DLS category method, the ecoregion where applied and the total number of times that the method was applied by ICES in its advice released in 2012.

Table 2.2.1.1. According to the ICES' Data-limited Stock (DLS) Approach (ICES CM 2012/ACOM:36 and ICES CM 2012/ACOM:68), ICES provided quantitative catch advice for stocks without analytical forecasts from five ecoregions. See the General Context of ICES Advice (Section 1.2) for a description of each category. The number of stocks is enumerated for each DLS category by ecoregion.

	Ecoregion					
DLS Category	Baltic Sea n=7	Bay of Biscay & Iberian Waters n=24	Celtic Sea & West Coast of Ireland n=36	North Sea n=27	Widely Distributed n=39	Total
2.1.3			2	1	1	4
3.1.0	1			1		2
3.1.2				1		1
3.1.4		3	1		2	6
3.2.0	6	7	14	6	11	44
3.3.0					4	4
4.1.2			1			1
4.1.3			2			2
4.1.4			1	5		6
5.2.0		12	6	9	8	35
5.3.0		1		1	5	7
6.2.0		1	6	1	4	12
6.3.0			3	2	4	9

Based on the final column in Table 2.2.1.1, it was decided that priority should be given to the DLS Category methods 3.10, 3.20, 3.30, 4.1.3 and 4.1.4. Brief details of the simulation approaches to be developed and applied before the third and final meeting of WKLIFE are as follows:

Simulations for methods 3.1.0 and 3.2.0

Simulations have already been conducted for a number of ICES groups (de Oliveira *et al.*, 2010, 2012a, b, de Oliveira, 2012). The approach now will be to look at the situations-to-be-addressed under Methods 3.1.0. and 3.2.0, both from the point of view of the types of stocks that have been identified in these categories by WKLIFE II, and the types of data issues relevant to these stocks, and to draw on the already-available simulation work to see whether these can be used to cover the situations-to-be-addressed. For any gaps identified, further simulation work will be undertaken. The purpose of these simulations (both the current and potential future work, where necessary) is to investigate the robustness of the proposed methods, given the types of stocks and data they will be applied to within ICES.

Simulations for Method 3.3.0

Simulations of the HCR based on survey abundance indices using a rule where the TAC is based on a specified F_{proxy} and lowering the exploitation rate below a specified $I_{trigger}$. Problems with defining the target reference points F_{proxy} and $I_{trigger}$ will be considered.

Sensitivity to the form of stock–recruitment relationship and measurement errors in the survey will be simulation tested. For both the measurement error in the survey and the residuals from the stock-recruitment function both the coefficient of variation (CV) and autocorrelation of the residuals will be of interest. Stocks with high autocorrelation of recruitment residuals are problematic. Also effects of a non-linear relationship between stock size and an abundance index that are not accounted for will be tested.

The effect of catch stabilization will be tested but only by relatively simple methods. All tests will be compared to advice base on analytical assessment in terms of total yield and variability of yield.

The simulation model to be used is written in AD Model Builder (Fournier *et al.*, 2012) but the addition of an *observation module* to a GADGET model might be considered to introduce more sized based aspects into the simulations.

Simulations for Method 4.1.3

Simulation work has already been undertaken on methods that just use catch information (e.g. pseudo-cohort analysis, un-tuned VPA and catch-curve analysis; de Oliveira *et al.*, 2010, 2012b), and all these methods were shown to perform poorly in the context they were used. Nevertheless, a catch-curve analysis method was used for Method 4.1.3 during 2012, and the suggested approach is to first evaluate whether current simulation work is relevant to this method, and if not, to conduct further simulation work to evaluate the performance of this method.

Robustness tests for Method 4.1.4

Full evaluation through simulation is not possible for the *Nephrops* stocks dealt with under this DLS approach. Instead, a robustness test is planned in which for each data-rich stock one will imitate the DLS approach assuming that all other data-rich stocks (i.e. having a TV survey) remain as candidate sources from which to borrow stock density estimates. The resulting DLS advice will be compared to the actual advice given for 2013 in the 2012 round of advice.

The lead institute was discussed and agreed during WKLIFE II for each of the methods which will be further investigated through simulation testing:

- For the DLS Category 3.1 method, DTU-Aqua (Denmark) will lead on the simulations.
- For the DLS Category 3.2 and Category 4.1.3 methods, Cefas (UK) will lead on the simulations.
- For the DLS Category 3.3 method, MRI (Norway) will lead on the simulations.
- For the DLS Category 4.1.4 method, Cefas (UK) and Marine Science (Scotland) will lead on the simulations.

The results will be presented at the third and last meeting of WKLIFE III in late 2013.

2.3 Target categories

For the data-limited stocks in Table 1.1.1, the participants at WKLIFE II discussed the categorization of methods and their information requirements. Table 2.3.1 indicates the information requirement of each category/method (denoted by x) and optional information requirements (denoted by (x)):

Table 2.3.1. Information requirements for the DLS Categories 1 to 6.

	Information Required					
Category	Population estimate	Survey	Fishing mortality	Biomass	Discards	Landings
1	x	x	x	x	x[1]	x
2	trends	(x)	trends	trends	(x)	x
3		trends	relative	relative	x[1,2]	x[2]
4					x[1]	X
5					(x)	X
6						(x)

[1] Either available, or can assume to be zero.

[2] If the landings or catches are unreliable, a directional advice (qualitative) can be given.

Unexpectedly, it became apparent during the discussions within WKLIFE II that the DLS Categories 1 to 6 do not represent a hierarchy of methods but merely a useful categorization. With this in mind, a number of observations can be made:

1) Moving from category to category requires a robust framework. Testing the robustness of the ICES Data-limited Approach should be a priority by the ICES Working Group on Methods of Fish Stock Assessment (WGMG).

2) The differentiation between conservation objectives and yield should be examined for the different categories.

3) PSA should be used to make choices between which stocks could be moved up in category and those that can remain in their current category based on an assessment of vulnerability. WKLIFE III should examine this at the ecoregion.

4) A DCF stock should have length composition available; therefore, such stocks should move from categories 5 and 6 to category 4. Database infrastructure is needed to facilitate this.

While the completion of the simulation testing of individual methods is a priority, there is a need to investigate the robustness of the ICES DLS approach to decreasing information; namely, for a Category 1 stock, would ICES advice be robust to treating the stock as a Category 2 stock, for example? This was discussed with the Chair of ICES WGMG during WKLIFE II and agreed that WGMG is well-placed to undertake such an evaluation.

3 Data-limited Stocks to be reassessed in 2013

ICES used the DLS category/methodology for its advice in 2012 but not all of the methods identified (ICES CM 2012/ACOM:68) were applied. For 2012, the DLS stocks are summarized by category/method as follows:

Category 2, Method 2.1.3, Stocks: whg-iris, whg-scow, cod-kat (three in total)

Category 3, Method 3.1.0, Stocks: ple-eche, ple-21-22-23 (two in total)

Category 3, Method 3.1.2, Stocks: ple-skag (one in total)

Category 3, Method 3.1.4, Stocks: nep-VIIIc (FU 31), nep-VIIIc (FU 25), nep-ixa (FU 26-27), guq-nea, dgs-nea, rjb-celt (six in total)

Category 3, Method 3.2.0, Stocks: ang-78ab, ang-ivvi, had-iris, meg-rock, mgw-78, ple-celt, ple-iris, pand-sknd, nep-2829, nep-30, Nep-2324, bll-2232, dab-2232, fle-2232, her-31, ple-2432, tur-2232, bsf-89, bsf-nrtn, gfb-comb, arg-oth, lin-faro, lin-oth, sbr-x, tusk-oth, tusk-rock, syc-bisc, syc-celt, syc-8c9a, syc-347d, trk-nea, rjc-bisc, raj-mar, rjc-347de, rjm-347d, rjn-347d, rjr-347d, rjc-VI, rjc-7afg, rje-7fg, rjm-VI, rjm-7afg, rjn-celt, rjn-bisc (44 in total)

Category 3, Method 3.3.0, Stocks: bli-5a14, arg-icel, lin-icel (three in total)

Category 4, Method 4.1.2, Stocks: pol-celt (one in total)

Category 4, Method 4.1.3, Stocks: ple-7h-k, sol-7h-k (two in total)

Category 4, Method 4.1.4, Stocks: nep-2021, nep-5, nep-10, nep-32, nep-33, nep-34 (six in total)

Category 5, Method 5.2.0, Stocks: spr-celt, spr-ech, hom-nsea, gug-347d, mut-347d, pol-nsea, spr-kask, Spr-nsea, whg-kask, jaa-10, ple-89a, pol-89a, sol-8c9a, whg-89a, bss-comb, gur-comb, mut-west, bli-5b67, lin-arct, rng-1012, tusk-arct, gag-nea, gur-celt, rjh-4c7de, raj-347d, rjh-VI, rjh-7afg, rji-celt, rjf-celt, rjm-bisc, rjm-pore, rjn-pore, rjc-pore, rjh-pore, raj-89a (35 in total)

Category 5, Method 5.3.0, Stocks: pand-flad, sck-nea, bli-oth, por-nea, agn-nea, bsk-nea, rjb-89a (seven in total)

Category 6, Method 6.2.0, Stocks: cod-rock, gug-celt, ple-7b-c, san-scow, sol-7b-c, whg-rock, gug-89a, alf-comb, sbr-ix, rng-oth, raj-ech (eleven in total)

Category 6, Method 6.3.0, Stocks: nop-scow, cyo-nea, rng-kask, tusk-mar, rju-ech, rjb-347d, rju-7j, raj-celt (eight in total)

3.1 Guidance for reopening DLS advice in 2013

The ICES spreadsheet of assessed stocks was discussed during the WKLIFE II meeting with respect to the data-limited stocks only. The following eight rules were applied to categorize stocks into those for which advice may be reopened in 2013 and those for which advice would not be reopened in 2013.

1) If it is biennial advice, the advice will not be reopened (e.g. elasmobranchs, deep sea and *Nephrops*);

2) If no basis for catch advice or quotas, lowest possible landings, zero catch advice then the advice will not be reopened (e.g. elasmobranchs, category 5.3);

3) If indices are available and used as the basis of advice, and the PAB has not been applied, the advice may be reopened;

4) If indices are available and used as the basis of advice, and the CAP and PAB have been applied, the advice should be re-examined, e.g. Northern shrimp (*Pandalus borealis*) in Divisions IIIa and IVa East (Skagerrak and Norwegian Deep);

5) If there are doubts about the method applied, the advice should be reexamined in 2013, e.g. Megrim (*Lepidorhombus whiffiagonis*) in Divisions VIIb–k and VIIIa,b,d;

  5.1) This should be looked at by ACOM and WGCHAIRS and coordinated with the stock coordinators;

6) When the PAB applied, advice will not be reopened (e.g. category 3.2.0);

  6.1) There are two exceptions to this rule. Northern shrimp (*Pandalus borealis*) in Divisions IIIa and IVa East (Skagerrak and Norwegian Deep) should be re-examined (survey index) and new advice should be issued if the index is substantially different. This also includes the short-lived Anchovy stock in IXa;

7) For 4.1.2 stocks, the DCAC method should be re-examined in 2013 due to the *slow up–fast down* nature of the method; and

8) If there are benchmarks, then advice should be reopened, e.g. two *Nephrops* FUs in category 4.1.4.

In the case of those stocks for which advice will not be reopened in 2013, there will need to be agreement on standard wording to be used; i.e. the reiteration of 2012 advice may need further elaboration for some stocks where, for example, technical measures are referred.

Of the data-limited stocks assessed in 2012 by ICES, 15 stocks should have their advice re-examined in 2013 and 13 should be reopened. These stocks are listed in Table 3.1.1.

Table 3.1.1. Of the data-limited stocks assessed in 2012 by ICES, 15 stocks should have their advice re-examined in 2013 and 13 should be reopened.

Stock	Stock name	EcoRegion	DLS Category	Uncertainty Cap	PA Buffer	New Advice in 2013?	Reasoning
nep-32	*Nephrops* in the Norwegian Deep (FU 32)	North Sea	4,1,4	no	no	re-examine	Based on 2013 benchmark
nep-34	*Nephrops* in Devil's Hole (FU 34)	North Sea	4,1,4	no	no	re-examine	Based on 2013 benchmark
ple-7h–k	Plaice in Divisions VIIh–k (Southwest of Ireland)	Celtic Sea and West of Scotland	4,1,3	yes	yes	re-examine	Method requirement
nep-2021	*Nephrops* in the FU 20–21 (Labadie, Baltimore, Jones and Cockburn)	Celtic Sea and West of Scotland	4,1,4	no	no	re-examine	Method requirement
sol-7h–k	Sole in Divisions VIIh–k	Celtic Sea and West of Scotland	4,1,3	no	yes	re-examine	Method requirement
nep-5	*Nephrops* in Botney Gut–Silver Pit (FU 5)	North Sea	4,1,4	no	no	re-examine	Method requirement
nep-10	*Nephrops* in Noup (FU 10)	North Sea	4,1,4	no	yes	re-examine	Method requirement
nep-33	*Nephrops* off Horn's Reef (FU 33)	North Sea	4,1,4	no	no	re-examine	Method requirement
ple-skag	Plaice in Subdivision 20 (Skagerrak)	North Sea	3,1,2	NA	NA	re-examine	No PA Buffer, but survey used
ple-eche	Plaice in Division VIId (Eastern Channel)	North Sea	3,1,0	yes	NA	re-examine	No PA Buffer, but survey used
ple-2123	Plaice in Subdivisions 21, 22, and 23 (Kattegat, Belts, and Sound)	Baltic	3,1,0	NA	NA	re-examine	No PA Buffer, but survey used
pand-sknd	Northern shrimp (*Pandalus borealis*) in Divisions IIIa and IVa East (Skagerrak and Norwegian Deep)	North Sea	3,2,0	yes	yes	re-examine	PA Buffer & survey used
mgw-78	Megrim (*Lepidorhombus whiffiagonis*) in Divisions VIIb–k and VIIIa,b,d	Celtic Sea and West of Scotland	3,2,0	yes	yes	re-examine	PA Buffer used, but needs method check
ane-pore	Anchovy in Division IXa	Bay of Biscay and Atlantic Iberian waters	5,2,0	NA	NA	re-examine	Short-lived species

Stock	Stock name	EcoRegion	DLS Category	Uncertainty Cap	PA Buffer	New Advice in 2013?	Reasoning
pol-celt	Pollack in Subareas VI and VII (Celtic Sea and West of Scotland)	Celtic Sea and West of Scotland	4,1,2	NA	NA	re-examine	stepwise DCAC
boc-nea	Boarfish in the Northeast Atlantic	Wide	3,3,0	NA	no	yes	Annual advice
had-iris	Haddock in Division VIIa (Irish Sea)	Celtic Sea and West of Scotland	3,2,0	no	no	yes	Based on 2013 benchmark
spr-kask	Sprat in Division IIIa (Skagerrak-Kattegat)	North Sea	5,2,0	NA	yes	yes	in year advice
Spr-nsea	Sprat in Subarea IV (North Sea)	North Sea	5,2,0	no	no	yes	in year advice
ang-78ab	Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Divisions VIIb–k and VIIIa,b,d	Celtic Sea and West of Scotland	3,2,0	no for *L. pisc*/ yes for *L. bud*	no	yes	Survey data used
ang-ivvi	Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Division IIIa, and Subareas IV and VI	Celtic Sea and West of Scotland	3,2,0	no	no	yes	Survey data used
meg-rock	Megrim (*Lepidorhombus* spp) in ICES Division VIb (Rockall)	Celtic Sea and West of Scotland	3,2,0	NA	no	yes	Survey data used
ple-iris	Plaice in Division VIIa (Irish Sea)	Celtic Sea and West of Scotland	3,2,0	no	no	yes	Survey data used
ple-2432	Plaice in Subdivisions 24–32 (Baltic Sea)	Baltic	3,2,0	yes	no	yes	Survey data used
dab-2232	Dab in Subdivisions 22–32 (Baltic Sea)	Baltic	3,2,0	yes	no	yes	Survey data used
Bll-2232	Brill in Subdivisions 22–32 (Baltic Sea)	Baltic	3,2,0	yes	no	yes	survey data used
her-31	Herring in Subdivision 31 (Bothnian Bay)	Baltic	3,2,0	yes	no	yes	Survey data used
fle-2232	Flounder in Subdivisions 22–32 (Baltic Sea)	Baltic	3,2,0	no	no	yes	Survey data used

3.2 Management considerations–implications for quota and uptake issues

The use of average catch as a reference to be modulated in producing a quantitative advice (methods in DLS Categories 3–6) has created difficulties with the application of the advised catches as TACs for 2013. These arise:

a) when there are uptake issues in the fishery between countries (specific issue related to the application of relative stability in EU fisheries; i.e. one or more countries do not fully utilize their quota). In this situation, the use of average catch translated into a TAC would have a greater than intended effect on the exploitation rate;

b) when the landings data do not adequately represent the out take due to fishing because of incomplete landings data or discarding, in these cases a TAC implemented on the basis of the catch advised will not have the intended effect on exploitation because there are catches not limited by the TAC; e.g. discards or recreational fisheries; and

c) where the landings arise only from very small volumes of by-catch; in these cases the implementation of the catch advice as TAC restrictions on minor by-catch species which are not in step with fishing opportunities for the target species in the mixed fisheries, only serve to convert the landings into discards, and likely do not affect the exploitation rate as intended by the catch advice. This situation is best addressed through the development of mixed fisheries plans.

For those situations where the catch advice given by ICES in 2012 is not to be reopened, ICES should endeavour to address the above issues in the 2013 advice and work programme.

3.3 Productivity and Susceptibility Analysis (PSA)

This method is designed to give an indication of vulnerability of species to impact by a fishery. The method combines an estimate of productivity with an estimate of susceptibility. The two factors are combined to estimate vulnerability. Thus, a species with high productivity and low susceptibility would be considered to have low vulnerability to local extirpation, whereas a species with very low productivity but highly susceptible to a series of factors associated with fishing would be rated as highly vulnerable. It should be noted that PSA does not deal with the role of the species within the ecosystem, e.g. sprat, but one should recognize that low risk species could be important in the ecosystem. Species with very high productivity will be at low risk due to fishing, but taking large numbers of certain species could put other species at risk, for example, species that depend on the first species as food.

3.3.1 Uses

PSA could be used to separate out the high risk from low risk species. If all species in a region are rated, PSA scores could be used to decide whether any species needs special management considerations. For example, low risk species could be managed according to the appropriate method depending on what is known about their population levels. On the other hand, high risk species may need management other than changes in yield, such as detailed technical measures, or no take.

PSA could be used to rationalize the precautionary buffer. For example, species that have very low vulnerability scores might not be subject to any precautionary buffer, whereas those in the middle and high vulnerability categories might be subject to increasingly high precautionary buffers. An example might be a species where we otherwise have little beyond basic productivity information, such as green crabs. They would most likely be rated as low vulnerability so would need little in the way of a precautionary buffer.

PSA could be used to compare risk among assessed species. All species within an ecoregion would be plotted with the assessed species in bold. This would enable a comparative risk analysis to be conducted for species about which little is known.

An example of the use of PSA to assess vulnerability of species in various groups can be found in Patrick *et al*. (2010). Those same criteria were used by Watling *et al*. (2011) for the deep-water species from the North Atlantic. In general, deep-sea sharks and orange roughy were shown to be the species groups most vulnerable to the impact of fishing. One could suggest that had a PSA or equivalent risk analysis been conducted for orange roughy; larger precautionary buffers or other caps could have been put in place that would have allowed the fishery to exist for a longer period of time, or perhaps have been sustainable.

One caveat: The susceptibility criteria need to be re-examined and there should probably be a workshop to decide what those criteria should be. Problems with the current list of susceptibility criteria are outlined in Watling *et al*. (2011).

3.4 Length-based reference points

DATRAS (ICES on-line database of trawl surveys, covering the Baltic Sea, Skagerrak, Kattegat, North Sea, English Channel, Celtic Sea, Irish Sea, Bay of Biscay and the eastern Atlantic from the Shetlands to Gibraltar) contains sex, maturity, length- and weight-at-age data for many ICES stocks that lack full assessments; these data are available under the SMALK formatted files in DATRAS. In addition, DATRAS contains length–frequency data for nearly all stocks, including data-limited ones in the cpue length–haul data. These files are available for direct downloading from the ICES website, or on request to ICES staff.

This information, together with published life-history traits such as compiled in FishBase (a global species database of fish species), can be used to establish the following population characteristics: age (t_{mat}) and length (L_{mat}) at 50% maturity, length–weight relationship, von Bertalanffy growth parameters (Linf (L_∞), K, t_0), mean length at first capture (L_c), length where growth rate in weight is maximum (L_{opt}), and the theoretical length resulting from fishing with F = M ($L_{(F=M)}$). With weighted mean length in the catch (L_{mean}) as indicator, several of these population characteristics can be used as reference points to infer relative exploitation and relative stock status. In other words, these length-based reference points can be used as proxies when fishing mortality and biomass are unknown.

3.4.1 Length at first capture (L_c) as reference point

L_c is the length class where 50% of the individuals are vulnerable to, and retained by, the gear. Overfishing is theoretically impossible if all individuals are allowed to reproduce at least once (Myers and Mertz, 1998). Thus, after a period of about generation time, biomass is probably above the biomass that can produce *MSY* if the length at first capture (L_c) in the fishery is above the length at first maturity (L_{mat}). A reasonable proxy for generation time (the average age of spawners in the unexploited stock) is the age at L_{opt}, which is given by

$$t_{opt} = \ln(3)/K + t_0 \approx 1.1 / K.$$

In a length–frequency curve, L_c can be determined as the length at half of the maximum frequency in the ascending part of the curve. The examples given here use the survey based data which use small-meshed gear. Therefore, it would also be useful to examine fishery-based data, including discards data, since this would enable the length at first capture of the fishery to be estimated.

3.4.2 Length-at-maturity (L_{mat}) as reference point

The length at first maturity is typically established from the inflection point of an S-shaped curve fitted to the fraction of females with ripe or spent gonads over the respective length or age. Thus, 50% of the females have ripening or spent gonads at this age or size. But ripening gonads are often found in surprisingly small females which, because of their small size and low fecundity, are unlikely to contribute significantly to future recruitment.

Thus, either multipliers are used such as 1.2 L_{mat} (Froese and Sampang, 2012), or empirical equations connecting maturation with asymptotic length can be used (e.g. Froese and Binohlan, 2000; Gislason *et al*., 2008; Le Quesne and Jennings, 2012). In these examples because the survey data did not always correspond to the spawning period, for some species, fish with 'maturing' or stage 2 gonads were considered likely to spawn. However, corroboration in terms of other data on length-at-maturity would be useful.

If the mean length in the catch, over a period about equal to the generation time, is below the length at first maturity, it means that there are more juveniles than adults in the catch, that therefore the age structure is likely to be truncated and that biomass is below the one that can produce MSY, and possibly at biomass levels below $B_{MSY\text{-}trigger}$, where recruitment may be impaired.

In contrast, if mean length (L_{mean}) is above length-at-maturity (L_{mat}), the stock is likely to be above $B_{MSY\text{-}trigger}$.

3.4.3 L_{inf} and L_{opt} as reference point

The largest specimens of a stock found in DATRAS are often an indication of the size that fish can reach if they manage to escape from fishing. These data are thus useful to inform the asymptotic length of the von Bertalanffy growth function; i.e. L_{inf} should not be (much) smaller than the largest specimens found. Fitting a growth curve to length-at-age data in DATRAS is often problematic, because old specimens are missing, and presentation of young specimens is biased because small specimens per age class are not yet in the area or not retained by the gear. Most weight should be given to data of length classes that are fully retained; i.e. to the right of the peak in the length–frequency analysis.

L_{inf} itself is an interesting reference point, as it indicates the degree of truncation of the age structure if close to no specimens get near this size. A better reference point is L_{opt} = 2/3 of *Linf* (L_∞), which is the length where growth in weight peaks, where cohort biomass has a maximum in the unexploited stock, where therefore egg-production has a maximum, where a given *F* obtains the highest catch, and where a given catch causes the lowest *F*. This is the optimum harvest length.

If L_{mean} is close to L_{opt}, then either the stock is very lightly exploited, or the fishery has succeeded in using L_{opt} as a target length for sustainable fishing close to *MSY*.

3.4.4 $L_{(F=M)}$ as reference point

Beverton and Holt (1957, p. 41) give the equation for mean length in the catch as a function of von Bertalanffy growth parameters, natural mortality, fishing mortality, and length at first capture. This equation can be rearranged and simplified to give the mean length in the catch that would result from fishing at *F* = *M;* for example, a period equal to generation time.

$L_{(F=M)} = (3 * L_c + Linf)/4$

This reference point can be compared with the respective observed mean length in the catch: if L_{mean} is smaller than $L_{(F=M)}$, then *F* is likely to be larger than *M*. If $F_{MSY} \approx M$, then $F > F_{MSY}$. Thus, $L_{(F=M)}$ can be used as a proxy reference point for F_{MSY}.

3.4.5 Applications of length-based reference points

The methods adopted for estimating these reference points are described in full for North Sea turbot and then their application in the assessment of a number of stocks is illustrated.

Growth in length data was obtained from the SMALK formatted files in DATRAS. The von Bertalanffy growth function was obtained from FishBase for some stocks or from fitting to the growth data for others including turbot, allowing for a bias against large and small fish.

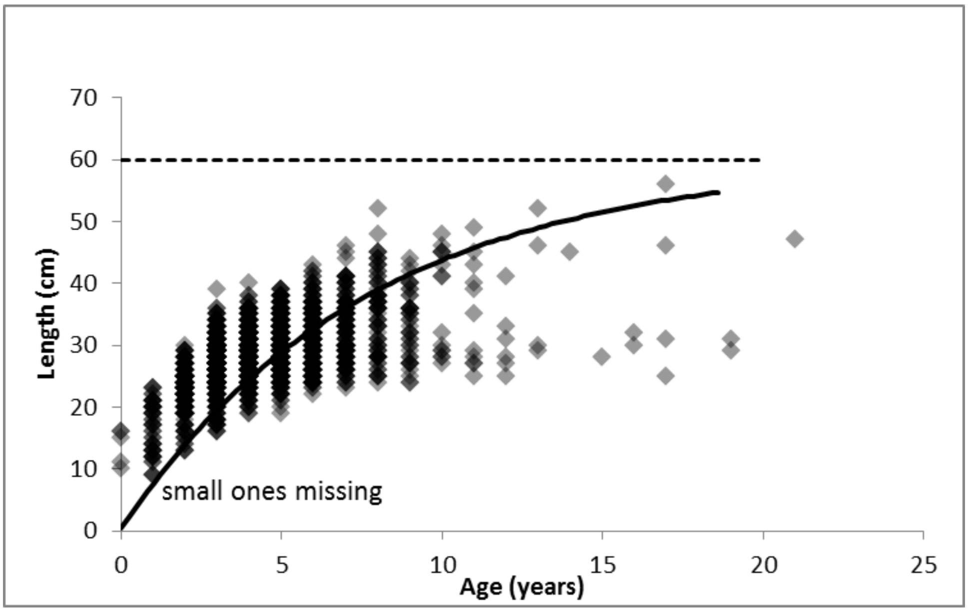


Figure 3.4.5.1. Growth in length of North Sea turbot.

In this case, von Bertalanffy parameters were estimated to be;

Linf	60 cm
K	0.13 $year^{-1}$
t_0	-0.06 year

Based on an Linf of 60 cm $L_{opt} = 2/3 * 60$ cm = 40 cm

The length-at-maturity was estimated by plotting the proportion of females from SMALK of stage 2 maturing or above as from ICES maturity key. In this case L_{mat} is estimated at 18 cm.

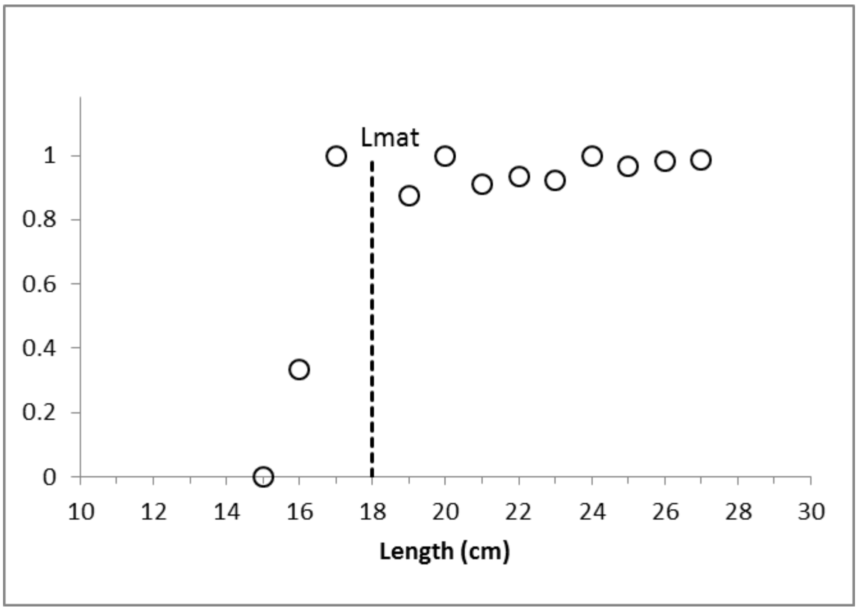


Figure 3.4.5.2. Maturing (Stage 2 and above) female turbot proportion vs. length.

The length–frequency distribution was plotted from the sum by length group of the catch per effort from the North Sea IBTS trawl survey from 2000–2012 (Figure 3.4.5.3). L_c was calculated as shown in Figure 3; where N= N_{max}/2 or half way up the ascending limb of the curve. In this case L_c =25 cm. L_{mean} is the mean length of fish of larger than L_c, shaded blue in Figure 3.4.5.3. To calculate $L_{(F=M)}$ = (3 * L_c + Linf)/4 = (3 * 25 + 60)/4 = 33.75 cm.

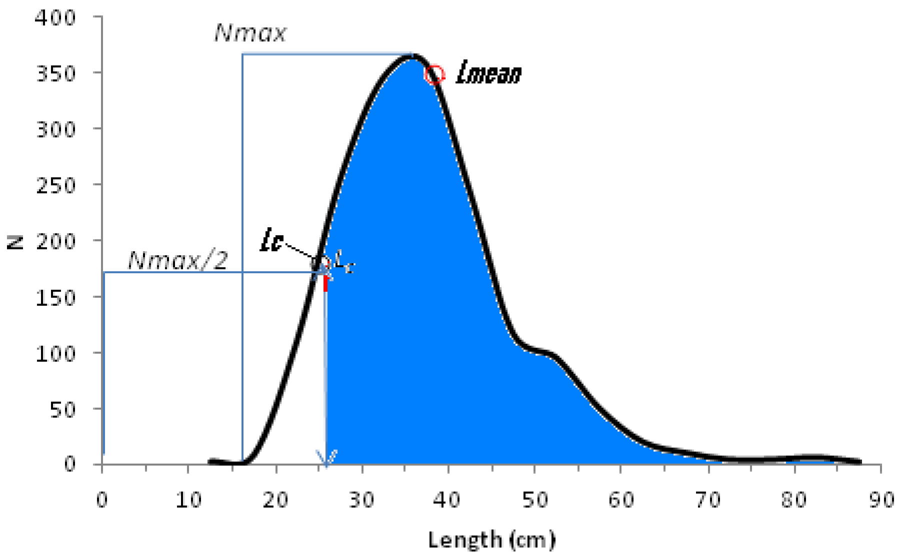


Figure 3.4.5.3. Plot of length–frequency distributions summed for North Sea turbot showing calculation of L_c and L_{mean}; area shaded used to calculate L_{mean}.

Total mortality coefficient Z

This is estimated from the slope of the descending limb of the Log_e catch curve;

$$\frac{d\,(Log_e N)}{dt} = -Z\,N$$

where Z is the total mortality coefficient and N is the numbers in successive age groups and t is time.

To calculate age, the von Bertalanffy growth curve was used as a continuous age–length key of the length–frequency distribution obtained from the summed catch per effort data. Numbers-at-length were converted into numbers-at-age from by calculating the mean age of the fish in each one of the length distribution 'bins' used to plot the length distribution using the formula;

Age-at-length = $-Log_e$ (1- Mid Bin Length / Linf)/K

Log_e N in each age group were calculated from the numbers in each bin and plotted as a catch curve below. A linear regression was used to estimate Z over the range of ages considered valid. Of course this method estimates steady state mortality over the period of time, and would not be robust to large changes in recruitment. It is used as an indicator of mortality.

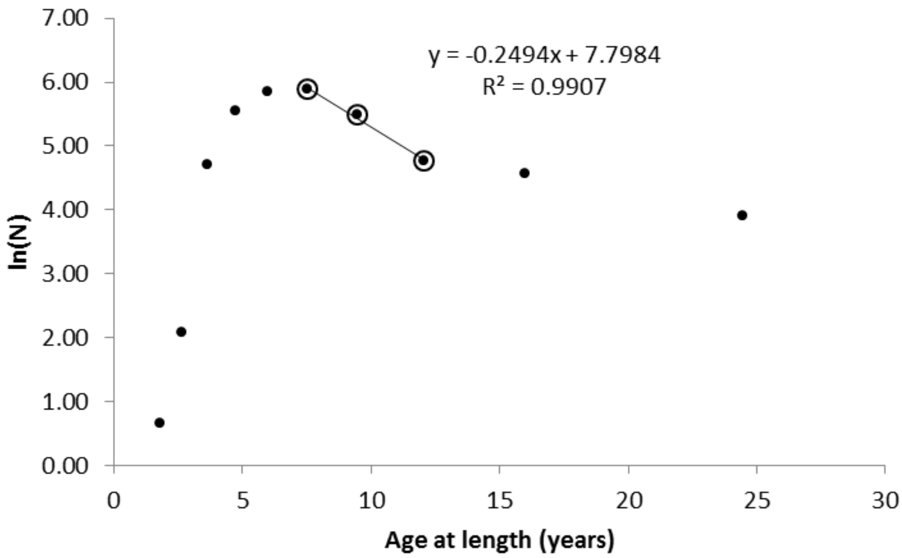
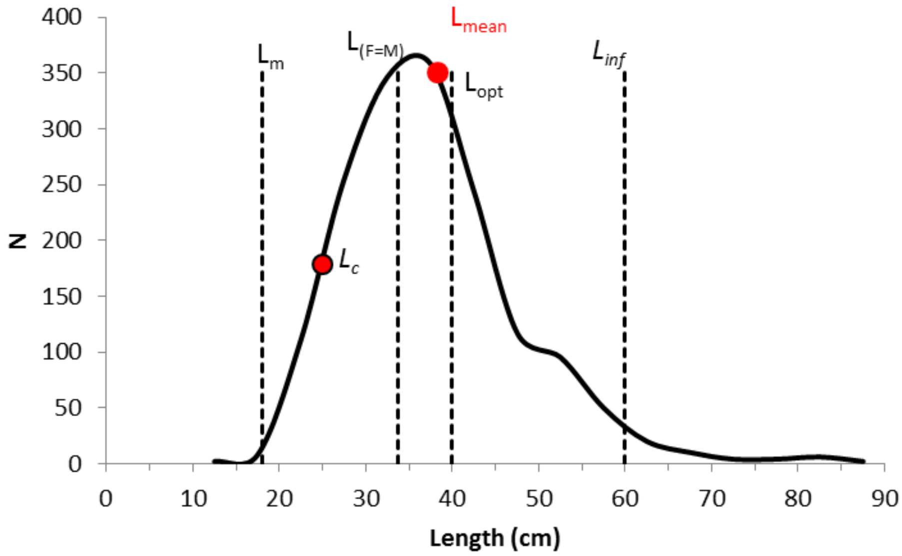


Figure 3.4.5.4. Estimation of Z from catch curve.

3.4.5.1 Examples

North Sea Turbot (*Psetta maxima)*

Length–frequency analysis using catch per hour data summed for period 2000–2012.



Z= 0.25

Figure 3.4.5.1.1. Length based assessment for North Sea turbot.

Assessment

- $L_c > L_{mat}$, thus, if L_c is also true for the commercial fishery, SSB is probably > SSB_{MSY};
- $L_{mean} > L_{mat}$ and > $L_{(F=M)}$, thus, F probably < F_{MSY}. However, L_{mat} has been quoted in FishBase as high as 46 cm for the North Sea, so care is required in the interpretation of maturity information;
- L_{mean} is close to L_{opt}, suggesting a modest fishing mortality;
- Z = 0.25 is based on only three points, but suggests low fishing mortality;
- Only concern from this analysis is an apparent decrease in maximum length and length-at-maturity.

Conclusion

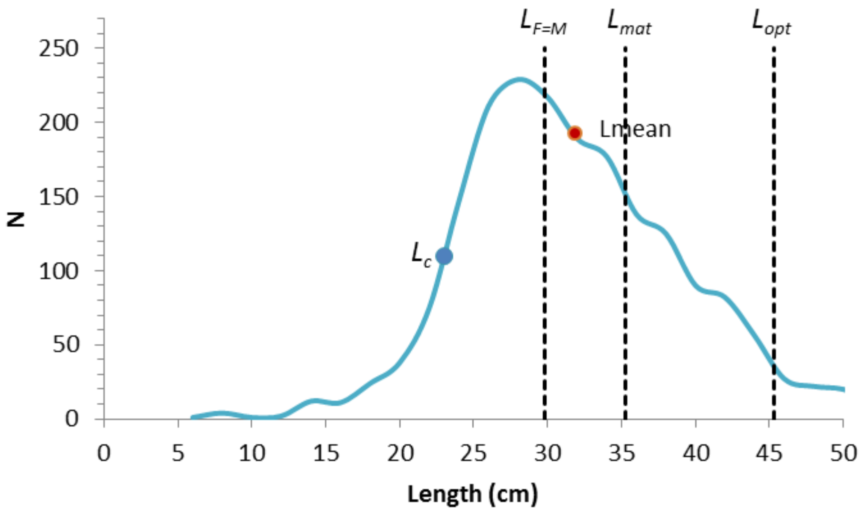
Catches could be increased if capture of specimens below 35 cm is avoided.

Table 3.4.5.1.1 Length based assessment for North Sea turbot.

Variable	Estimate	Source
L_{mat}	18 cm	Estimated from DATRAS
L_{inf}	60 cm	Estimated from DATRAS
K	0.13 year-1	Estimated from DATRAS
T_0	-0.06 year	Estimated from DATRAS
L_{opt}	40 cm	Estimated from DATRAS
L_c	25 cm	Estimated from DATRAS
$L_{(F=M)}$	33.75 cm	Estimated from DATRAS
L_{mean}	38.3 cm	Estimated from DATRAS
Z	0.25 from length based model	

North Sea brill (*Scophthalmus rhombus*)

Length–frequency analysis using catch per hour data summed for period 2000–2012.



Z= 0.77

Figure 3.4.5.1.2. Length based assessment for North Sea brill.

Assessment

$L_c < L_{mat}$, thus, if L_c is also true for the commercial fishery, SSB is probably at risk of being below SSB_{MSY} or $MSYB_{trigger}$. The observation that L_{mean} is below L_{mat} is also indicative of a risk of SSB being below B_{MSY} or MSY $B_{trigger}$. However, L_{mean} is above $L_{(F=M)}$ indicating that F is below F_{MSY} although the L_{mean} is well below L_{opt}. The low value of $L_{(F=M)}$ is caused by the low L_c with the small-meshed survey gear. If L_c is higher in the commercial fishery, then $L_{(F=M)}$ would also be higher. So, the result of $L_{mean} > L_{(F=M)}$ has to be taken with caution. It is not supported by Z = 0.77, which suggests $F > F_{MSY}$ if typical values for M are assumed.

Conclusion

Aim for reduction of fishing mortality to reduce immediate risk to SSB and increase length at first capture towards L_{opt} in the longer term.

Table 3.4.5.1.2. Length based assessment for North Sea brill.

Variable	Estimate	Source
Lc	23 cm	DATRAS Survey data
L_{mean}	31.85 cm	DATRAS Survey data
L_{mat}	35.24 cm	Gislason *et al.*, (2008)
L_{inf}	68 cm	DATRAS Survey data
K	0.14 year^{-1}	DATRAS SMALK data
T_0	-1.74 year	DATRAS SMALK data
$L_{(F=M)}$	29.78 cm	DATRAS Survey data
L_{opt}	45.33 cm	DATRAS Survey data
Z	0.77	Regression from length based model

North Sea Lemon sole (*Microstomus kitt)*

Catch per effort data

Previous analysis of lemon sole data from DATRAS showed that there were three distinct periods in the catch per effort data. Pre-1982, 1983–1997 and 1998–2011. Pre-1982 the survey was not extensive as subsequently, so it is the 1983–1997 and 1998–2011 periods that were used in this analysis.

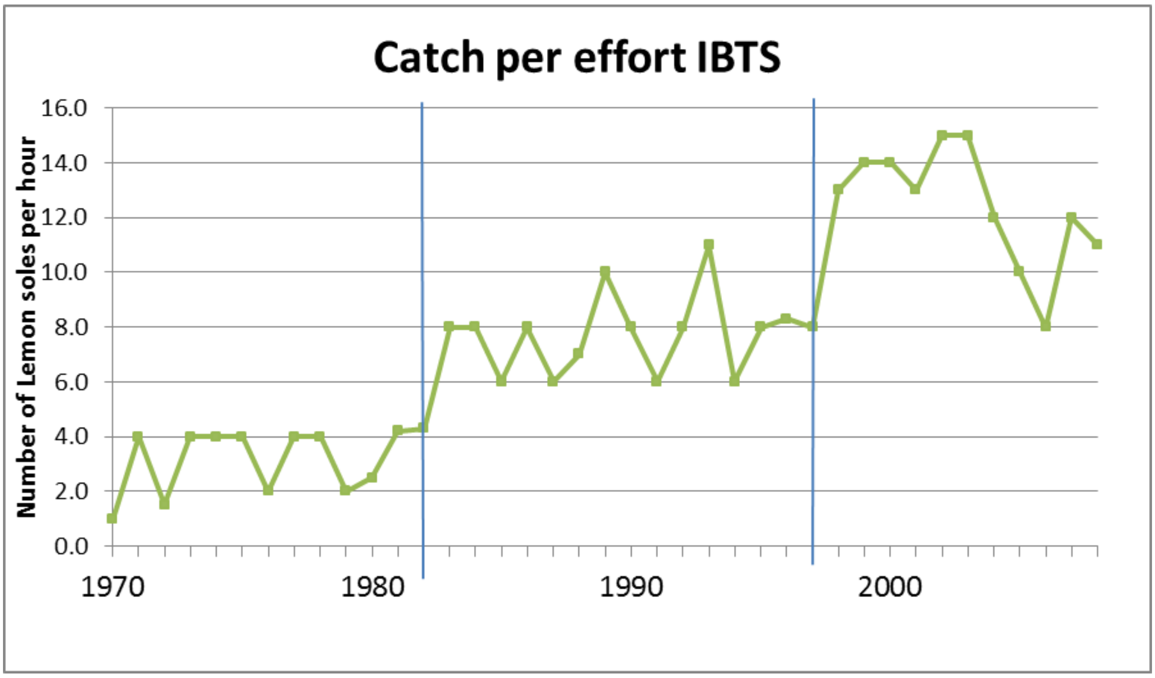


Figure 3.4.5.1.3. Mean catch per hour of lemon sole in IBTS trawl survey quarter 1 vs time as described by ICES WGNEW (ICES CM 2010/ACOM:21).

In order to examine trends in recruitment the catch per effort of fish less than 25 cm was examined in the DATRAS survey data (Figure 3.4.5.1.4). This indicates that much of the increase in numbers was probably due to recruitment.

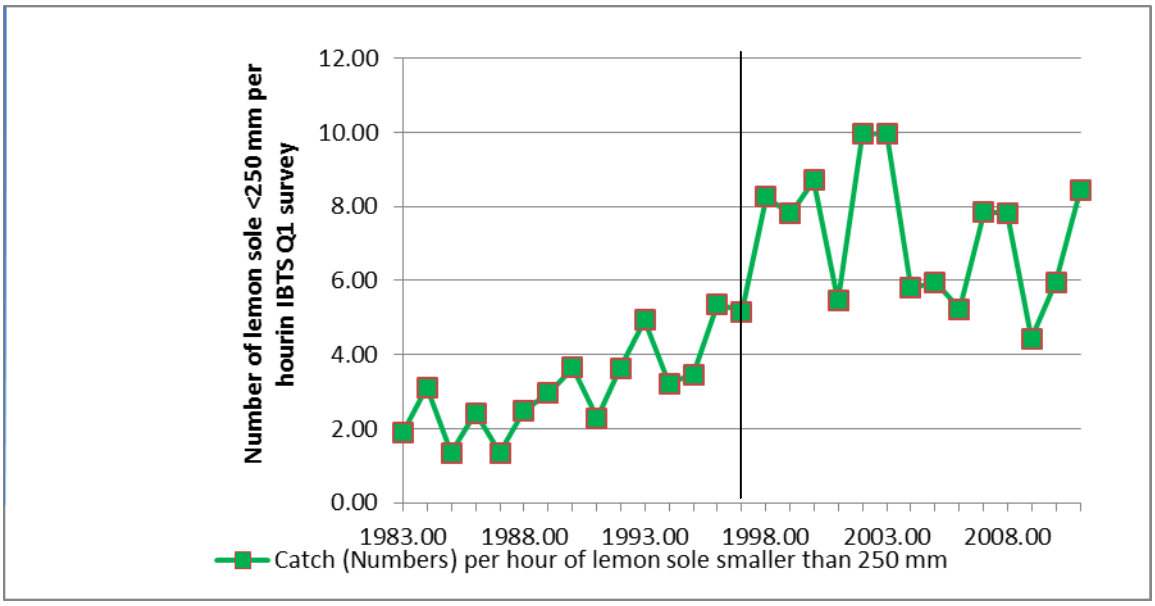
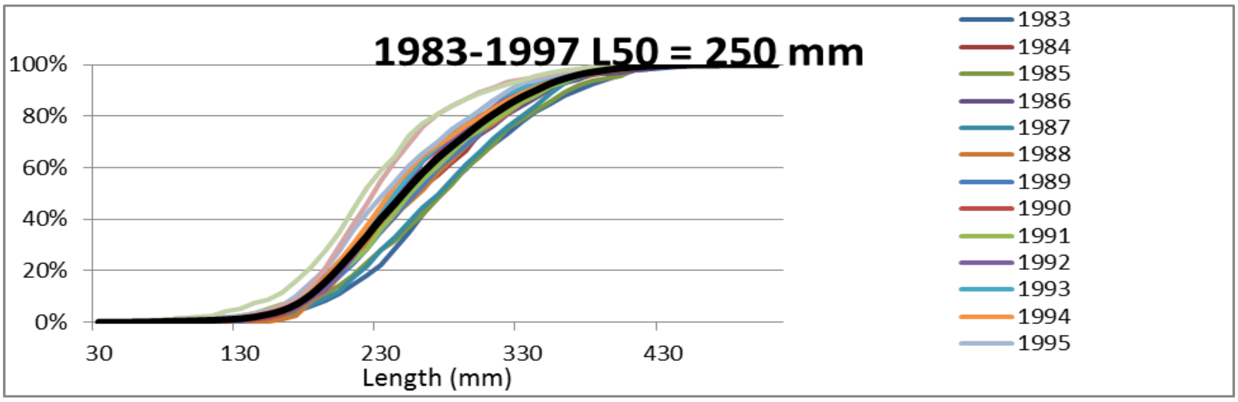


Figure 3.4.5.1.4. Mean catch per effort of small lemon sole (<25 cm) in the quarter 1 IBTS.

Lemon sole length distributions over time

The cumulative percentile length distributions (derived from IBTS quarter 1 data in DATRAS) are shown by year for these two periods below (Figure 3.4.5.1.5), with the black line corresponding to the mean curve for the period; L50 corresponds to the 50 percentile of the mean curve.



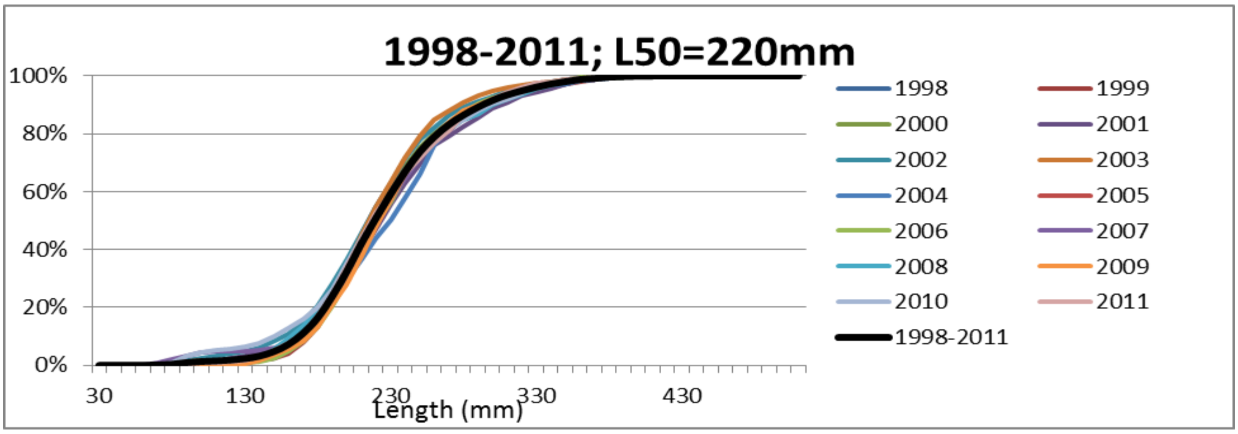
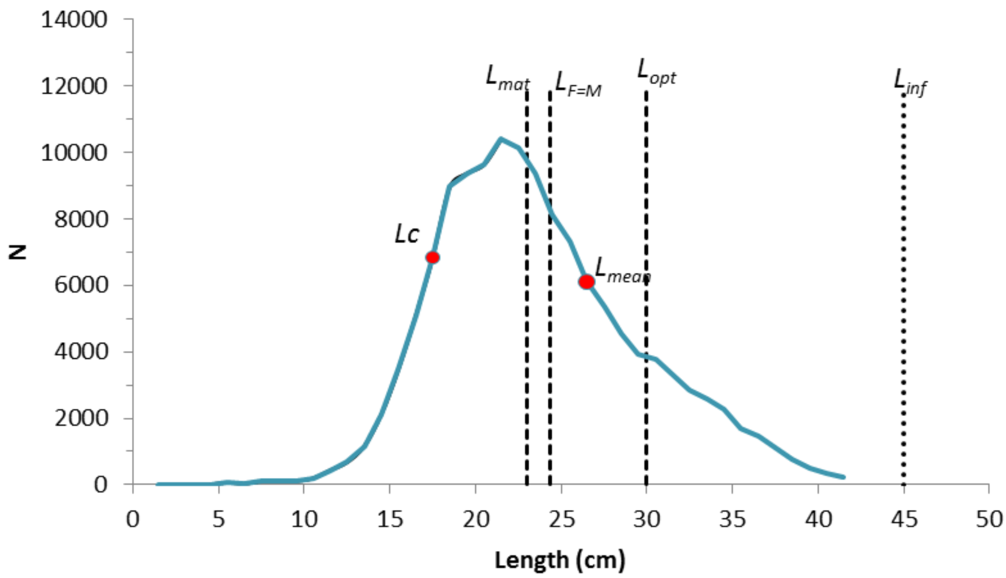


Figure 3.4.5.1.5. Cumulative percentile length distributions.

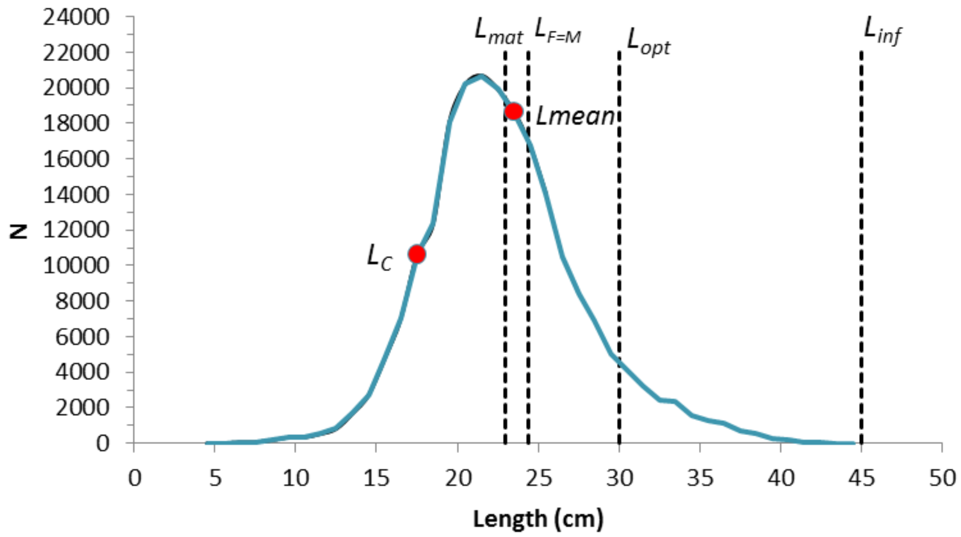
These results show that the two periods appear to be distinct. The cumulative curves for the period of time 1983–1997 are more variable with a higher overall mean L_{50} than the more recent period which has a tighter distribution and a smaller L_{50}. This has justified separating the length–frequency analysis into two separate periods.

Period 1983–1997



Z= 0.44

Period 1998–2011



Z=0.50

Assessment

L_{mat} is above L_c, although L_c from fishery data would probably be higher. Thus there is a risk that SSB is below SSB_{MSY} or MSY $B_{trigger}$. However we know from the time-series above that there is good recruitment especially after 1998 so there is less concern about SSB. Two contrasting situations:

- Period 1983–1997, L_{mean} is above $L_{(F=M)}$ so F was possibly below M or below proxy for F_{MSY}. However, L_{mean} is below L_{opt} where improved reproduction and yield would be expected;

- Period 1998–2011, L_{mean} just below $L_{(F=M)}$ suggesting that F has increased close to or above M corresponding our proxy for F_{MSY} to an increase in total mortality (Z). The increase in recruitment experienced in the period since 1998 does not appear to be *filling out* the population.

Conclusion

Aim to maintain fishing mortality, or reduce it slightly and work towards an increase in length at first capture towards L_{opt} = 30 cm. This will enable best yield-per-recruit and maximize the SSB. However, this assumes there are not density-dependent or natural mortality effects which would mitigate the recovery of the population. The fact that the population has achieved a length distribution more skewed towards L_{opt} in the past suggests that it would be feasible to recover to this situation and improve upon it.

Table 3.4.5.1.3. Length based assessments for North Sea lemon sole.

Period 1983–1997

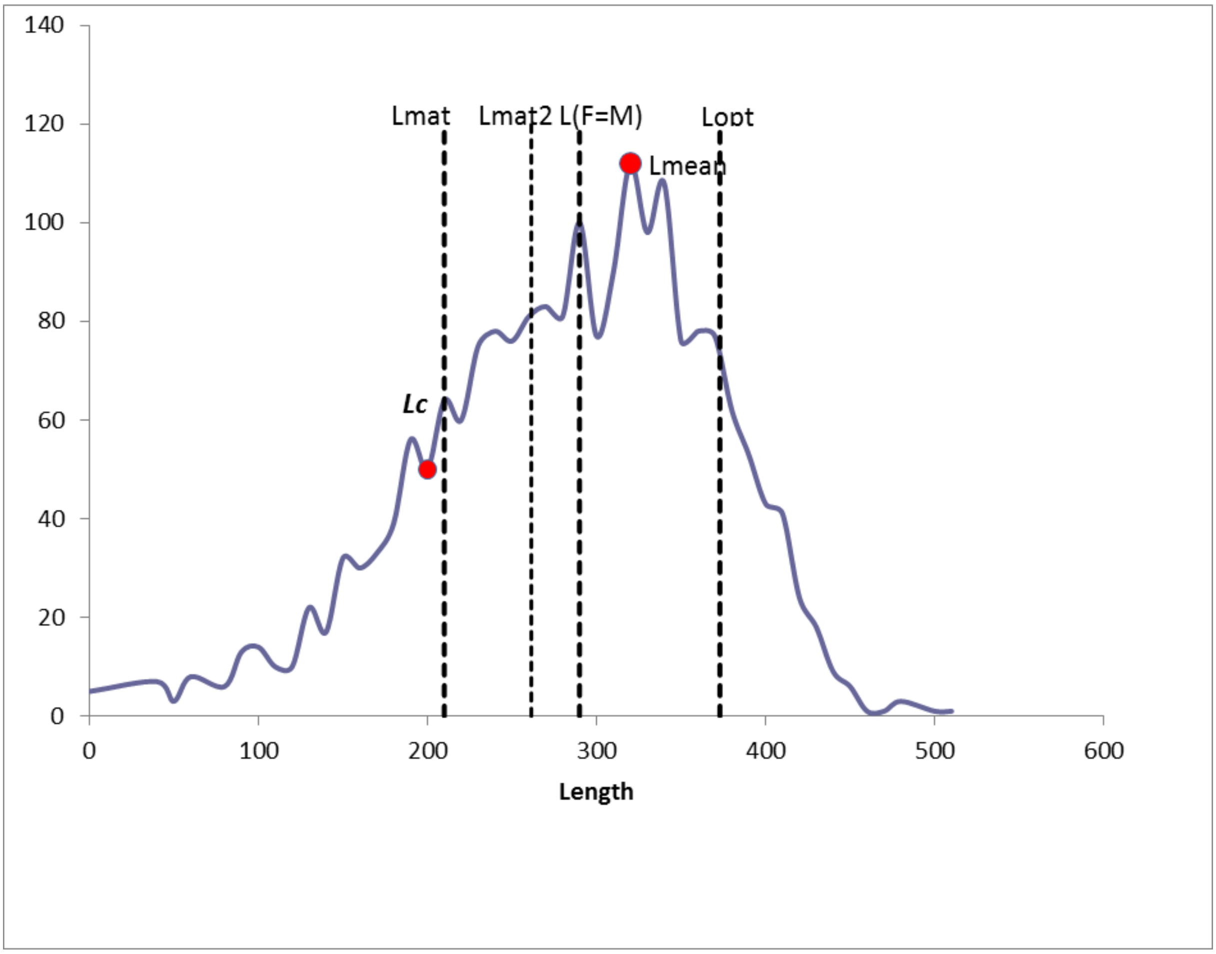
Variable	Estimate	Source
Lc	17.5 cm	DATRAS Survey data
Lmean	26.6	DATRAS Survey data
Lmaturity	23 cm	DATRAS SMALK
Linf	45 cm	DATRAS Survey data
K	0.22 $year^{-1}$	FishBase
T_0	-0.5 year	FishBase
$L_{(F=M)}$	24.4 cm	DATRAS Survey data
Lopt	30.0 cm	DATRAS Survey data
Z	0.44	Regression from length based model

Period 1983–2011; others as above

L_{MEAN}	23.2 cm	DATRAS Survey data
$L_{(F=M)}$	24.4 cm	DATRAS Survey data
Z	0.52	Regression from length based model

North Sea Witch Flounder (*Glyptocephalus cynoglossus*)

Length–frequency analysis using catch per hour data summed for period 2005–2012.



Z = 0.5

Assessment

We can see that from this length analysis mean length in the catch is higher than both length at first maturity (estimated with few data) and $L_{(F=M)}$.

Conclusion

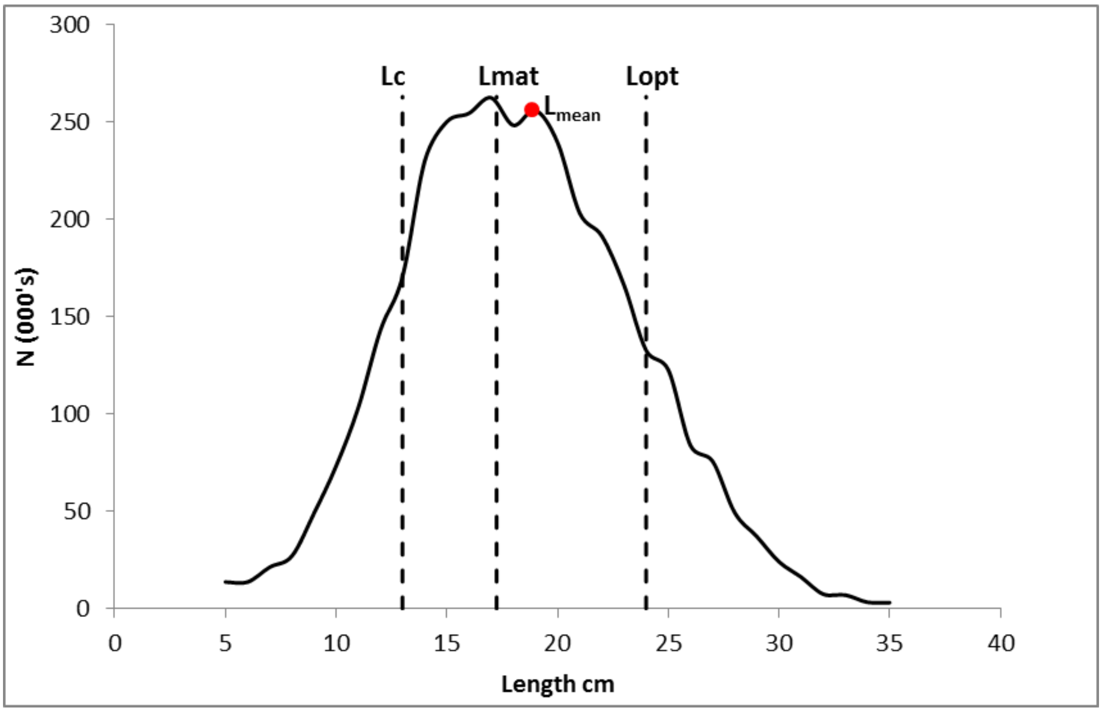
These results suggest that stock is exploited with F<M during this period (2005–2012), that is below our proxy for F_{MSY}, F=M. Note that ICES WGNEW 2010 (ICES CM 2010/ACOM:21) have undertaken a preliminary assessment of this stock. They suggest a yield-per-recruit (using M=0.1 and an XSA-based assessment) F_{MAX} of around 0.63 to 0.65 with current average F (F_{BAR}) being 0.35 to 0.6, having been 0.35 to 0.4 in 2010. Thus the location for the stock, on a yield-per-recruit basis, is similar to that estimated here; exploited below F_{MAX}, although the estimated F is much higher than the assumed M of 0.1.

Table 3.4.5.1.4. Length based assessment for North Sea witch flounder.

Variable	Estimate	Source
Linf	56cm	Estimated from DATRAS
K	0.2year^{-1}	DATRAS
T_0	-0.2	DATRAS
Lc	20 cm	DATRAS
Lmat	21 cm	DATRAS
Lmat2	26.1 cm	Gislason et al. (2008) method
Lmean	31.4 cm	DATRAS
$L_{(F=M)}$	29 cm	DATRAS
Lopt	37.4 cm	DATRAS
Z	0.5	Length based regression

North Sea dab (*Limanda limanda*)

Length–frequency analysis using catch per hour data summed for period 2012.



Z = 0.73

Assessment

L_c for the fishery is probably larger than shown here. L_{mat} is less than L_c so low risk of SSB being below MSY $B_{trigger}$. L_{mean} is just above $L_{(F=M)}$ suggesting that F is at or just below F_{MSY}. Z is quite high, this species is widely discarded and this may represent high discard mortality, but they also probably suffer predation.

Conclusion

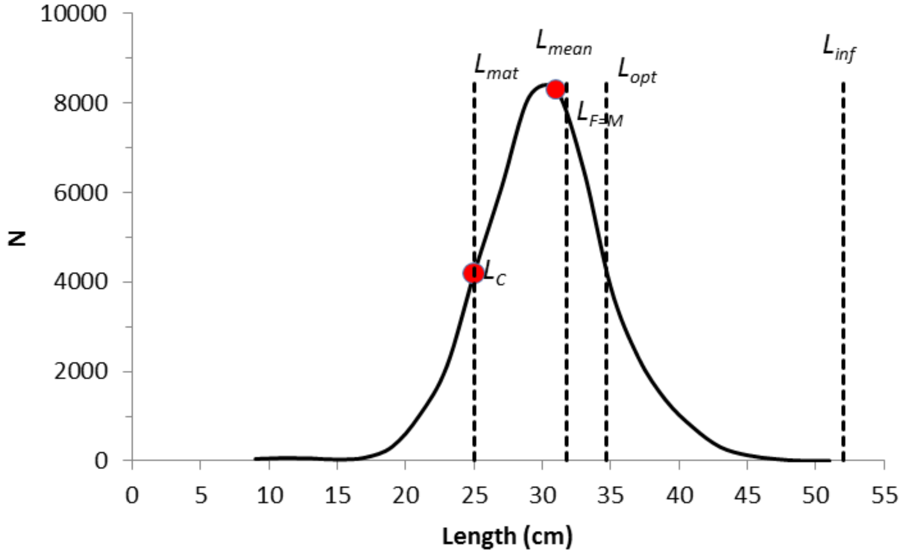
F close to F_{MSY}, SSB probably above MSY $B_{trigger}$.

Table 3.4.5.1.5. Length based assessment for North Sea dab.

Variable	Estimate	Source
Lc	11 cm	DATRAS
L_{mean}	18.9 cm	DATRAS
L_{mat}	13 cm	DATRAS
L_{inf}	36 cm	FishBase
K	0.4 year^{-1}	FishBase
T_0	0.3	FishBase
$L_{(F=M)}$	17.3 cm	DATRAS
L_{opt}	24.0 cm	Derived from FishBase
Z	0.73	Regression from length based assessment

North Sea flounder (*Platichthys flesus)*

Length–frequency analysis using catch per hour data summed for period 2011–2012.



Z= 0.8

Assessment

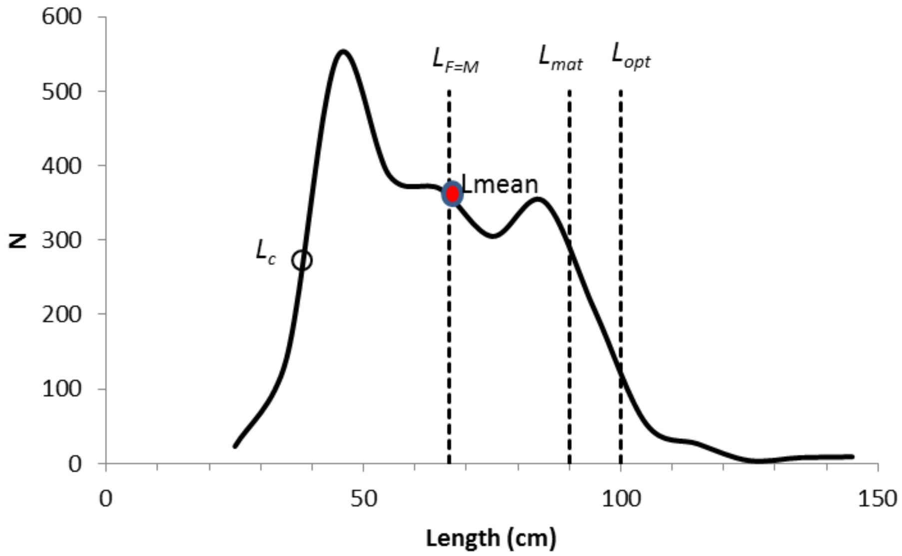
L_{mean} is just below $L_{(F=M)}$ which is our proxy for F_{MSY}, suggesting that the F is just above F_{MSY}. To bring stock closer to F_{MSY} catches should be reduced particularly of fish below 30 cm, thereby exploiting the stock closer to L_{opt}.

Table 3.4.5.1.6. Length based assessment for North Sea flounder.

VARIABLE	ESTIMATE
L_{mean}	30.8 cm
Lm	25 cm
L_{inf}	52 cm
K	0.22 $year^{-1}$
T_0	-0.5 year
$L_{(F=M)}$	31.8 cm
L_{opt}	34.7 cm
Z	0.8

Smooth-hound (*Mustelus* spp.)

Length–frequency distribution for smooth-hound sharks of the Genus *Mustelus* in the Northeast Atlantic, for the years 2000–2012.



Z= 0.65

Assessment

Length at first capture L_c, is much lower than length-at-maturity suggesting a risk to SSB. L_{mean} is much less than L_{mat} indicating a population dominated by immature fish and further suggesting a risk to SSB. Although L_{mean} is close to the point where fishing mortality equals natural mortality $L_{(F=M)}$, conserving SSB is probably the important priority so reducing fishing mortality and increasing size at first capture should be considered important.

Table 3.4.5.1.7. Length based assessment for Northeast Atlantic smooth-hound.

Variable	Estimate
Lc	38 cm
L_{inf}	153 cm
K	0.21 year^{-1}
Lm	90 cm
L_{opt}	100 cm
$L_{(F=M)}$	66.8 cm
L_{mean}	66.7 cm

4 Discussion and conclusions

4.1 Future Terms of Reference (ToRs)

The participants at WKLIFE II proposed the following terms of reference for a third and final meeting.

WKLIFE III–Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other key parameters for data-limited stocks

The Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks **(WKLIFE III)**, chaired by Carl O'Brien (UK) and Manuela Azevedo (Portugal) and will meet at ICES HQ, 28 October to 1 November 2013 to;

a) Build on the findings of past ICES groups, including WKLIFE, RGLIFE, WKFRAME, and the Data-Limited Stocks Methods document as well as other published sources to: Identify preferred options for determining proxies for F_{MSY} for stocks without quantitative forecasts, using life-history traits and exploitation characteristics;

b) Identify key methods for estimating current exploitation based on available limited information (for instance catch and survey data);

c) Investigate/define the methods to determine the relationship between life-history traits and the variance of stock development indices;

d) Identify the synergies in (a), (b) and (c) to make further advances in the development of quantitative methodologies for data-limited stocks;

e) Review the simulation work identified at WKLIFE II and make recommendations on current and future method choices for data-limited stocks;

f) Investigate the application of PSA to inform the advice for sustainable fisheries for data-limited and data-rich stocks. It should speak directly to the application (and magnitude) of the precautionary buffer for data-limited species. The susceptibility parameter(s), weightings (note-see NMFS), vulnerability, scaling, etc. should be designed for PSA criteria relevant to start the process, formalize/quantify each by ecoregion and then drill down to finer scales as required. To do this, ICES can build on the work of WKDDRAC3 (meeting in mid-January 2013), which will identify the data needed to improve the assessments of Northeast Atlantic stocks (NWWRAC, SWWRAC, and NSRAC).

g) Based on this work, make a proposal for reopening the DLS advice in the future.

4.2 Length-based reference points

For the stocks investigated in Section 3, it was found that values for the variables required were relatively easy to source either from DATRAS or from FishBase, although data on length at first capture would be better sourced from the fisheries if feasible. Obtaining values for L_{inf} were the most problematic since most of the populations contained relatively few large fish. Since L_{inf} has an influence on many of these variables it is important to obtain valid values, preferably from the area and latitude of the stock.

The combination of results from time-series extracted from DATRAS and the length-based analysis was particularly informative as discussed in the lemon sole example. It is possible to extract time-series for other parameters from DATRAS, too.

4.3 PSA

The susceptibility criteria need to be re-examined and there should be time available during the third and final meeting of WKLIFE III to decide what those criteria should be. Problems with the current list of susceptibility criteria are outlined in Watling *et al*. (2011).

As an example, Devin *et al*. (2012) assessed the ability of six grenadier species from the North Atlantic, North Pacific, and Southern Ocean to sustain deep-sea fisheries. These species are captured in high amounts as by-catch and a few are taken in targeted fisheries, yet population status for most is poorly known or known for only a small portion of their range. A productivity and susceptibility analysis showed that none of the species was highly productive. While grenadiers were ranked more vulnerable than species in the Northeast Pacific ground fish fisheries, none of the investigated species was ranked as highly susceptible or heavily exploited. Devin *et al*. (2012) exposed several weaknesses in the PSA technique and attribute scoring. These weaknesses need to be further explored within the context of stocks for which ICES provides advice.

4.4 Commentary on DLS categories 3 and 4

Category 3 stocks are those for which *survey indices (or other indicators of stock size such as reliable fishery-dependent indices [cpue and mean length in the catch) are available that provide reliable indications of trends in total mortality, recruitment and biomass*.

In this category, survey indices, such as cpue, are treated as equivalent whether they come from fisheries-independent data or from fisheries-dependent data. The scientific justification for this is weak. Survey data are obtained from sampling stations located in a random or stratified random design. It should go without saying that fisheries stations are located using various biases, but generally are repeats of locations that produced reasonable numbers of fish on previous occasions. Consequently, there is no way to make an unbiased estimate of any of the parameters called for under Category 3.

This problem is discussed in Walters and Martel's (2004) book *Fisheries Ecology and Management*. They note: 'Two main problems have caused dangerously misleading overestimates of abundance, recruitment, and net production during population declines and the onset of overfishing: (1) the use of commercial catch per unit of effort (cpue) or other relative-abundance indices that are, in fact, not proportional to abundance (Harley *et al*., 2001) and (2) changes over time in the size/age selectivities that confuse the interpretation of population composition data' (p. 94).

The first of these is especially problematical. Harley *et al*. (2001) showed for several ICES fish stocks, the commercial cpue remained high while the survey data showed that populations were declining (so-called *hyperstability*). That this can happen is due at least in part to the fact that experienced fishing boat captains can find areas where fish are concentrated, and some species may show severe contractions of their range just before the final collapse (for example, North American cod; see Myers and Cadigan, 1995).

The importance of these distinctions has to do with the fact that category 3 species can be exempt from applying the uncertainty cap or the precautionary reduction if it is felt that the abundances of the species are increasing or are at least stable. However, if the commercial cpue data are likely to be underestimating the degree to which the fish population may be maintaining itself, then such an exemption would be ill-advised.

Category 3 species should be those for which there is survey data to substantiate population abundance claims based on commercial cpue. However, if all that is available for estimating abundance is fishery-dependent data, those species should be assigned to category 4 and the application of the uncertainty cap and precautionary buffers be mandatory. As an example, one might look at the deep-sea fish, Black scabbardfish (*Aphanopus carbo*) in Subareas VI, VII, and Divisions Vb and XIIb. For that species, the claim has been made that abundances are stable at least, and perhaps increasing (WGDEEP, 2012). However, the only fishery-independent data for this species comes from surveys taken off Scotland but at depths much greater than where the commercial fishery operates, and those cpue values have very wide variances indicating extreme patchiness in the abundance values. With regard to fisheries-dependent cpue data, most come from French vessels that land most of the Black scabbardfish in these northern areas. But they may have contracted their fishing effort into a smaller number of ICES rectangles (compare ICES CM 2012/ACOM:17 with ICES CM 2009/ACOM:14) thus perhaps unwittingly producing *hyperstable* estimates.

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Annex B: Recommendations

RECOMMENDATION	FOR FOLLOW UP BY:
Section 2.3: Testing the robustness of the ICES DLS approach should be a priority.	WGMG
Section 2.3: To note WKLIFE II remarks on target categories for each of the data-limited stocks.	ACOM (December 2012)
Section 3.1: To note WKLIFE II proposal on the stocks to be reassessed in 2013 for advice on fishing opportunities in 2014.	ACOM (December 2012)