1.5.5.10   Assessment of data on fish diseases in the OSPAR maritime area

Request

An assessment of data on fish diseases in the OSPAR maritime area (OSPAR 13-2008)

To trial the fish disease index developed by ICES and reported at WKIMON III through application in an evaluation of data collected by OSPAR Contracting Parties with a view to providing an assessment of fish disease in the OSPAR maritime area for inclusion in the QSR 2010 to the extent possible. The assessment should consider the prevalence of externally visible fish diseases, macroscopic liver neoplasms and liver histopathology in common dab (Limanda limanda).

ICES responded to this request from OSPAR in 2008. However the data available in the ICES Data Centre were limited. ICES agreed to do the assessment again in 2009 when more data were available and some recommended revisions to the methodology had been made.

Source of information

ICES. 2009. Report of the Working Group on Pathology and Diseases of Marine Organisms (WGPDMO 2009)

Summary

ICES undertook a trial assessment of fish health data for dab available in the ICES Data Centre to explore the usefulness of a Fish Disease Index (FDI). Sufficient data were available to perform assessments for externally visible diseases and for macroscopic liver neoplasms in a number of ICES statistical rectangles. For externally visible diseases, 10 of the 14 ICES statistical rectangles assessed were characterized by a worsening of disease status, in either level (i.e., increased mean FDI for 2002–2007 as compared to mean FDI for 1992–2001), trend (significant pattern of increasing FDI values over the years 2002–2007), or both. For macroscopic liver neoplasms, only one rectangle showed an improvement in level of FDI.

The worsening of the disease status of dab in the majority of geographical areas assessed should be considered an alarm bell to stimulate more research on the identification of causes of this general phenomenon.

This trial application of a Fish Disease Index to the available fish health data clearly demonstrates the utility of this approach to assess fish health and to evaluate the impact of anthropogenic induced stresses on fish. There is considerable value in national laboratories making their fish health data available to the ICES Data Centre so that the disease assessment can be expanded in the future. It is also clear that there are many opportunities to build upon this approach to using the fish health data. For example, more data on macroscopic liver neoplasms and liver pathology data would permit an assessment of the impact of various chemical contaminants on fish health. ICES encourages the continuation and expansion of fish health monitoring programmes, the submission of additional fish health data, and the further development of the FDI and other approaches to using the fish health data.

ICES Response

Background information

A number of ICES Member Countries conduct wild fish disease surveys as part of their marine environmental monitoring and assessment programmes. In the OSPAR region, countries with regular monitoring activities applying ICES standard methodological guidelines (Anonymous, 1989; Feist *et al*., 1994) include Germany, the Netherlands and the UK. These activities are focused on the North Sea and adjacent areas, including the English Channel, the Irish Sea, and the Baltic Sea. Data from these activities are submitted to the fish disease database of the ICES Data Centre-EcoSystemData. The status of the database is detailed further below.

Wild fish disease studies are part of the general and the contaminant-specific biological effects component of the OSPAR Coordinated Environmental Monitoring Programme (CEMP). Countries presently perform such studies on a voluntary basis. Published guidelines are available (see above) and quality assurance is achieved through the BEQUALM programme (Biological Effects Quality Assurance in Monitoring Programmes; www.bequalm.org) and through ICES activities.

The Fish Disease Index (FDI) referred to in the request has been under development since 2005 (Lang and Wosniok, 2008) and has been critically reviewed by ICES on a number of occasions (ICES, 2006a, 2006b, 2007, 2008a).

However, in 2008 the OSPAR request for a data assessment could not be completed because a significant amount of data in national databases was not available in the ICES fish disease database. Therefore, the assessment was delayed until 2009. This delay also allowed for further refinements in the method.

Current status of disease data submissions to the ICES Data Centre

Annex 1 provides a comparison of disease data (only dab, *Limanda limanda*) available for the 2008 and 2009 assessments. New data submissions were received from Germany (BFCG) and from the UK (BODC). In total, data from 109 012 specimens were added to the 2008 database. The new data were both historic and current, from the years 2007 and 2008.

In total, the ICES fish disease database currently contains data on 645 220 individual dab. The majority of the data, for 406 569 specimens is from the vTI Institute of Fishery Ecology (BFCG) in Germany. However, the picture is still patchy because not all data on macroscopic liver neoplasms have been submitted and data on liver histopathology are still lacking completely. At present the majority of the data is for externally visible diseases.

Some disease data on other fish species (e.g., flounder, cod) are also available in the ICES fish disease database. However, the amount of data is presently insufficient for an assessment. Further data submissions from ICES Member Countries are anticipated and it is expected that an assessment of the updated database can be conducted in 2010.

The Fish Disease Index (FDI): components and assessment procedures

Following is a short description of the components used in the calculation of the FDIs as well as on the procedures developed for the assessment of changes in the diseases status of the fish. More details can be found in ICES (2009) and Lang and Wosniok (2008).

For the calculation of the FDI, the following components are required:

- Information on diseases of the common dab (*Limanda limanda*) (can be adapted to other fish species, provided that sufficient appropriate data are available);

- Data on the presence or absence of a range of diseases monitored on a regular basis, categorised as externally visible diseases (EVD: 9 key diseases, incl. 3 parasites), macroscopic liver neoplasms (MLN: 2 key diseases) and liver histopathology (LH: 5 key diseases) (see Table 1.5.5.10);

- For most diseases, data on 3 severity grades (reflecting a light, medium, or severe disease status) are included;

- Disease-specific weighting factors, reflecting the impact of the diseases on the host (assigned based on expert judgements);

- Adjustment factors for effects of size and sex of the fish, as well as for seasonal effects.

Table 2.5.5.10   Disease categories and key diseases to be used for calculating the Fish Disease Index for dab (*Limanda limanda*) (ICES, 2006b)

Externally visible diseases	Macroscopic liver neoplasms	Liver histopathology
Lymphocystis Epidermal hyperplasia/papilloma Acute/healing skin ulceration X-cell gill disease Hyperpigmentation *Stephanostomum baccatum* *Acanthochondria cornuta* *Lepeophtheirus pectoralis*	Benign neoplasms Malignant neoplasms	Non-specific lesions Early non-neoplastic toxicopathic lesions Pre-neoplastic lesions (FCA) Benign neoplasms Malignant neoplasms

The result of the calculation is a FDI value for individual fish (see below) which is scaled such that values range from 0 to 100, with low values representing healthy fish and high values representing diseased fish. The maximum value of 100 can only be reached in the purely theoretical and unrealistic case that a fish is affected by all diseases at their highest severity grades. From the individual FDIs, mean FDIs for a sample of fish from a particular population in a given sampling area can be calculated. Depending on the data available, FDIs can be calculated either for single disease categories, i.e. EVD, MLN or LH, or for combinations thereof.

The FDI methodology

The following terms are used when describing the changes in the FDI:

Individual FDI   Value of the FDI for an individual fish, calculated as

$$FDI = \sum_{i=1}^{I} x_i \cdot w_i$$, where

i Index for disease. In the present analysis:

     i = 1: *Acanthochondria cornuta*
     i = 2: Epidermal hyperplasia/papilloma
     i = 3: Hyperpigmentation
     i = 4: *Lepeophtheirus pectoralis*
     i = 5: Lymphocystis
     i = 6: S*tephanostomum baccatum*
     i = 7: Acute/healing skin ulceration
     i = 8: X-cell gill disease

x_i Indicates presence of disease i : $x_i = \begin{cases} 0 & disease\ i\ absent \\ 1 & disease\ i\ present \end{cases}$

w_i Weight to quantify the seriousness of the disease to the host based on expert judgements. This is not to be confused with the grade of the disease (mild, moderate, severe), which is not used here. (See Lang and Wosniok (2008))

In the special case of assessing only a single disease, the individual FDI corresponds to the absence/ presence information for a single fish.

Mean FDI   Mean value calculated from adjusted individual FDIs for a specified ICES statistical rectangle and a specified sampling day. The mean uses the individual FDIs of all fish in the sampling unit after adjustment for length effects that is specific for rectangle and sex. The mean is additionally corrected for season of the year, where the correction terms are derived from all data that enters the assessment, i.e. all rectangles for which assessments are shown.

In the special case of assessing only a single disease, the mean FDI corresponds to the disease prevalence, adjusted for length and season.

See Lang and Wosniok (2008) and ICES (2008a) for details on the adjustment procedures.

Learning phase   The period of time, in this case 1992 to 2001 used to infer the distributional properties of the mean FDI, essentially mean and standard deviation

Assessment phase   The period of time, in this case 2002 to 2007, for which an assessment of the mean FDI is to be performed.

The assessment

The assessment of the FDI data considers the FDI levels and the FDI trends in geographical units, i.e. the ICES statistical rectangles. This assessment approach does not use any background or reference values as is often done in assessments for chemical contaminants or for biochemical biomarkers. Instead, the assessment of the FDI values is based on the determination of the mean FDI within the geographical units over a given period of time, using region-specific assessment criteria. The reason for choosing this approach is the known natural regional variability of disease prevalence even in areas considered to be pristine. This makes it impossible to define generally applicable background/reference values that can be used for all geographical units. This approach requires the availability of

disease data over a longer period of time, ideally 10 observations over a period of 5 years, for every geographical area to be assessed.

The final products of the assessment procedure are:

- graphs showing the temporal changes in mean FDI values in geographical units over the entire observation period (see Figures 1.5.5.10 and 1.5.5.10.2), and
- maps in which the geographical units assessed are marked with green, yellow, or red smiley faces, indicating current changes (e.g., within the past 5 years) in health status of the fish population (green: improvement of the health status; yellow: no change; red: worsening of the health status, reason for concern and motivation for further research on causes) (see Figures 1.5.5.10.3 and 1.5.5.10.4).

The ICES fish disease database currently contains data from 645 220 specimens of dab from studies conducted during the period 1981–2008. Only one third of these data could be used for the assessment. Data could not be used because these (a) originated from periods of time outside the learning and assessment phase, (b) came from areas not considered in the assessment, or (c) did not meet the minimum requirements, i.e. 10 observations in the period 1992–2007, of which 5 were in the assessment period 2002–2007.

Assessments were based on 8 externally visible diseases (EVD) of dab; lymphocystis, epidermal hyperplasia/papilloma, acute/healing skin ulceration, x-cell gill disease, hyperpigmentation, *Stephanostomum baccatum*, *Lepeophtheirus pectoralis*, and *Acanthochondria cornuta*, and on macroscopic liver neoplasms (MLN). Originally it was anticipated that an assessment could be carried out on all 3 OSPAR CEMP disease categories, EVD, MLN, and liver histopathology (LH). However the ICES MLN data set is incomplete because some data held in national databases have not been submitted to ICES. This is at least partly because histological confirmation, required according to the ICES guidelines (Anon., 1989; Feist *et al.*, 1994) has not yet been performed. An assessment of LH data was not possible because relevant data obtained by Member Countries have so far not been submitted to ICES.

The FDI based on EVD is a reflection of the level and trend of the overall health status of dab captured at specified ICES statistical rectangles over the period 1992–2007, and is not considered a direct measure of effects of exposure to chemical contaminants. The FDI based on MLN is a reflection of the level and trend in prevalence and severity of liver neoplasms in dab at specified ICES statistical rectangles over the period 1992–2007. These liver neoplasms in wild fish have been associated with exposure to chemical contaminants such as PAHs and chlorinated hydrocarbons (e.g., PCBs) in numerous field studies in Europe and North America.
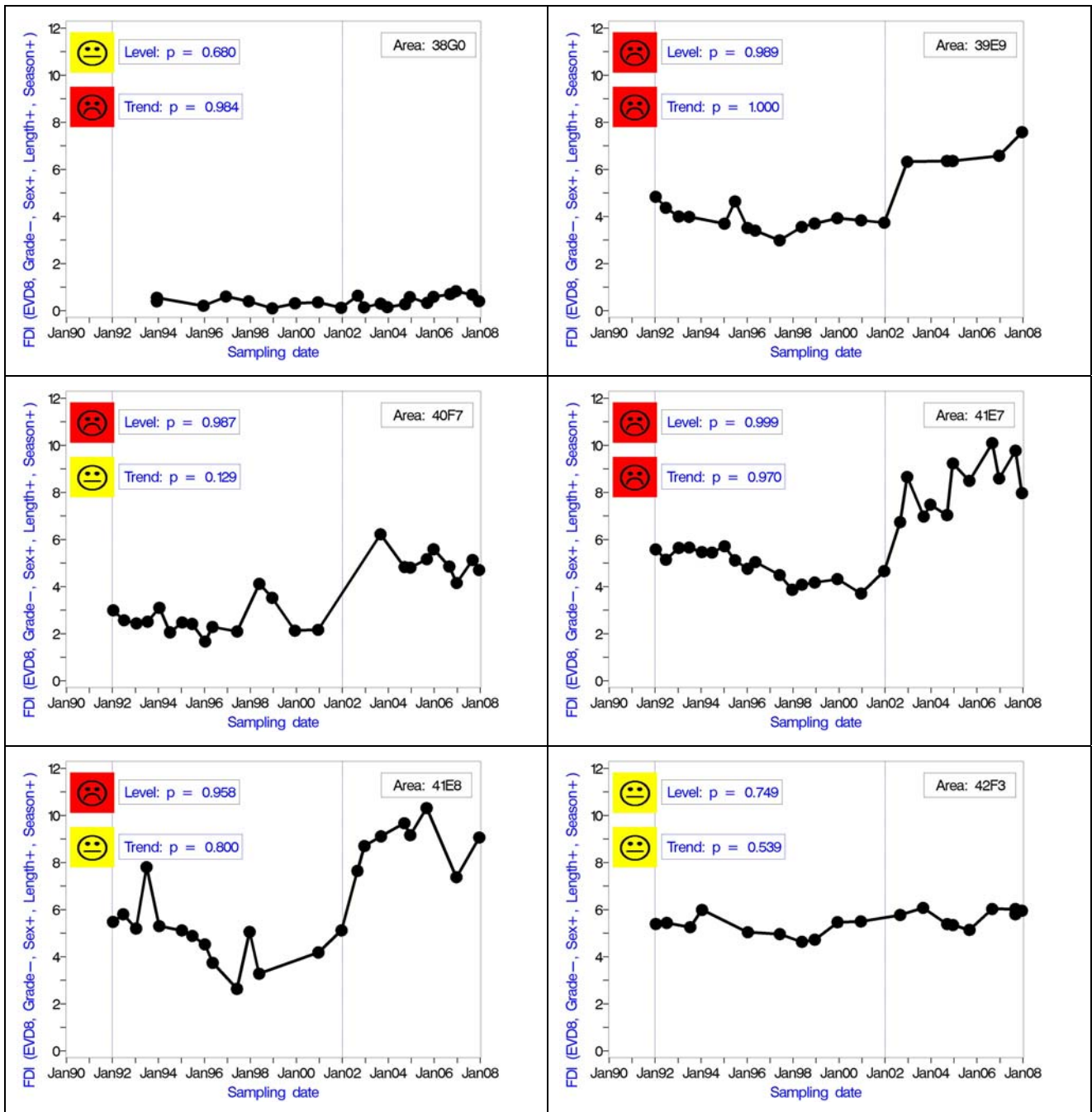
An assessment of levels and trends of the mean FDIs for externally visible diseases (EVD) in dab of the North Sea and adjacent areas (English Channel, western Baltic Sea) was conducted for 14 ICES statistical rectangles (Figure 1.5.5.10.3). These rectangles met the minimum data requirements of 10 observations in the period 1992–2007, of which 5 were in the assessment period 2002–2007).

Changes in the mean FDI in these 14 statistical rectangles for the periods 1992–2001 (learning phase) and 2002–2007 (assessment phase) are shown in Figure 1.5.5.10. The assessment (Figure 1.5.5.10.3) indicates that the levels of the FDI for EVD significantly increased in seven areas reflecting that the disease status related to EVD in the assessment period 2002–2007 was worse than in the "learning" period, 1992–2001 (red frowny faces). In the other seven areas significant change was detected in the FDI level (yellow indifferent faces). The assessment of trends in FDI means revealed that the disease status became worse in six areas (red frowny faces) with no significant trend in the other eight areas (yellow indifferent faces) during the assessment phase, 2002–2007. Only seven areas exhibited the same behaviour of change for level and trend (both either being constant or increasing) while the other seven areas showed different behaviour of level and trend. In no area was there a significant decrease in the FDI or a significant trend indicating an improvement in disease status.

For macroscopic liver neoplasms (MLN), an assessment was possible for six ICES statistical rectangles (Figure 1.5.5.10.4) that fulfilled the minimum data requirements. The changes in the mean FDI in these six statistical rectangles for the periods 1992–2001 (learning phase) and 2002–2007 (assessment phase) are shown in Figure 1.5.5.10.2. The FDI levels for MLN significantly improved in one of the areas (41E7) (green smiley face), while the disease status in another area (35E6) became worse (red frowny face). There was no significant change in the other four areas. There were no significant FDI trends related to MLN in the 6 areas assessed (yellow indifferent faces) (Figure 1.5.5.10.4). The ICES database for macroscopic liver lesions has not yet been updated completely and more data allowing a more comprehensive assessment will be available in the future.
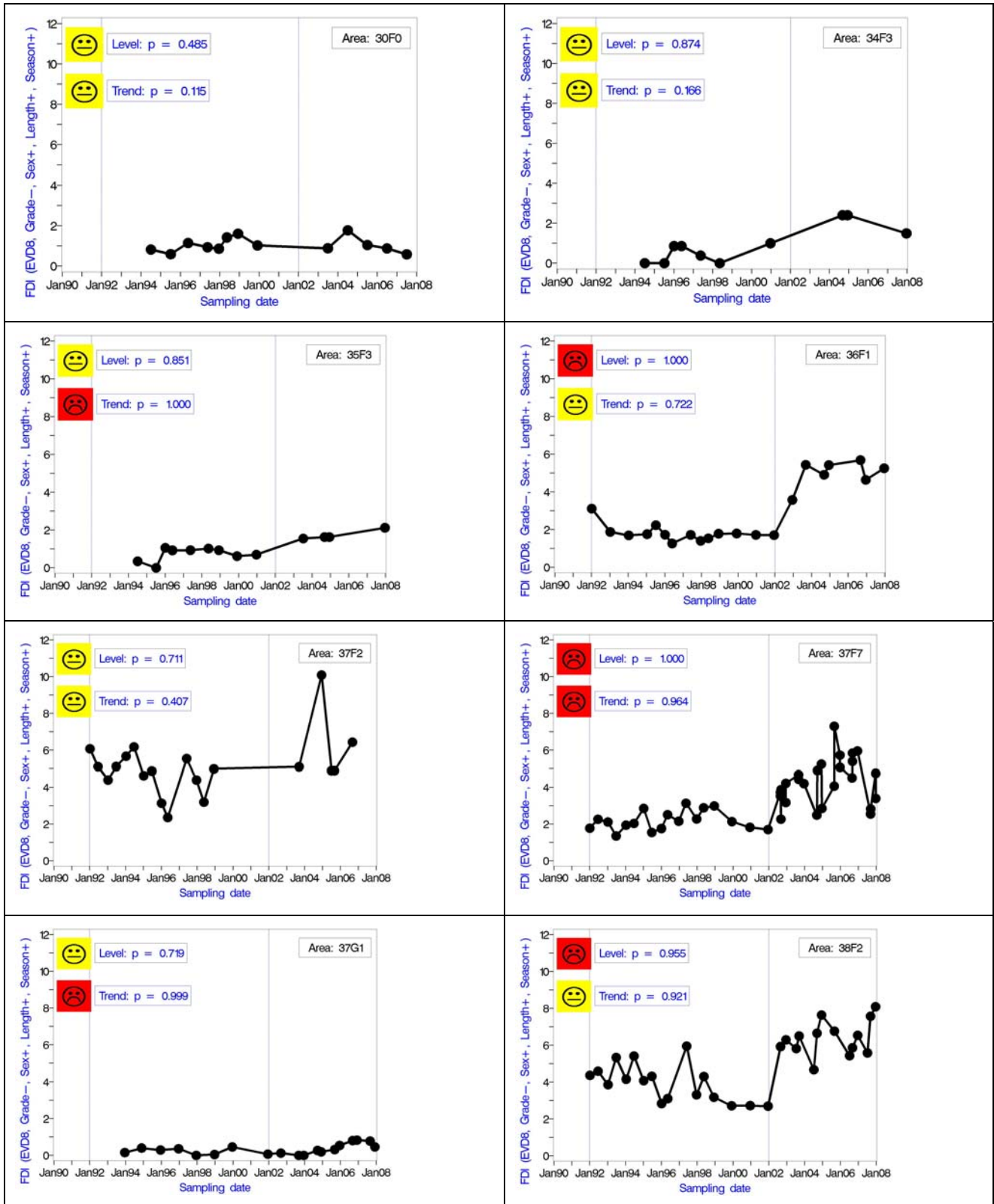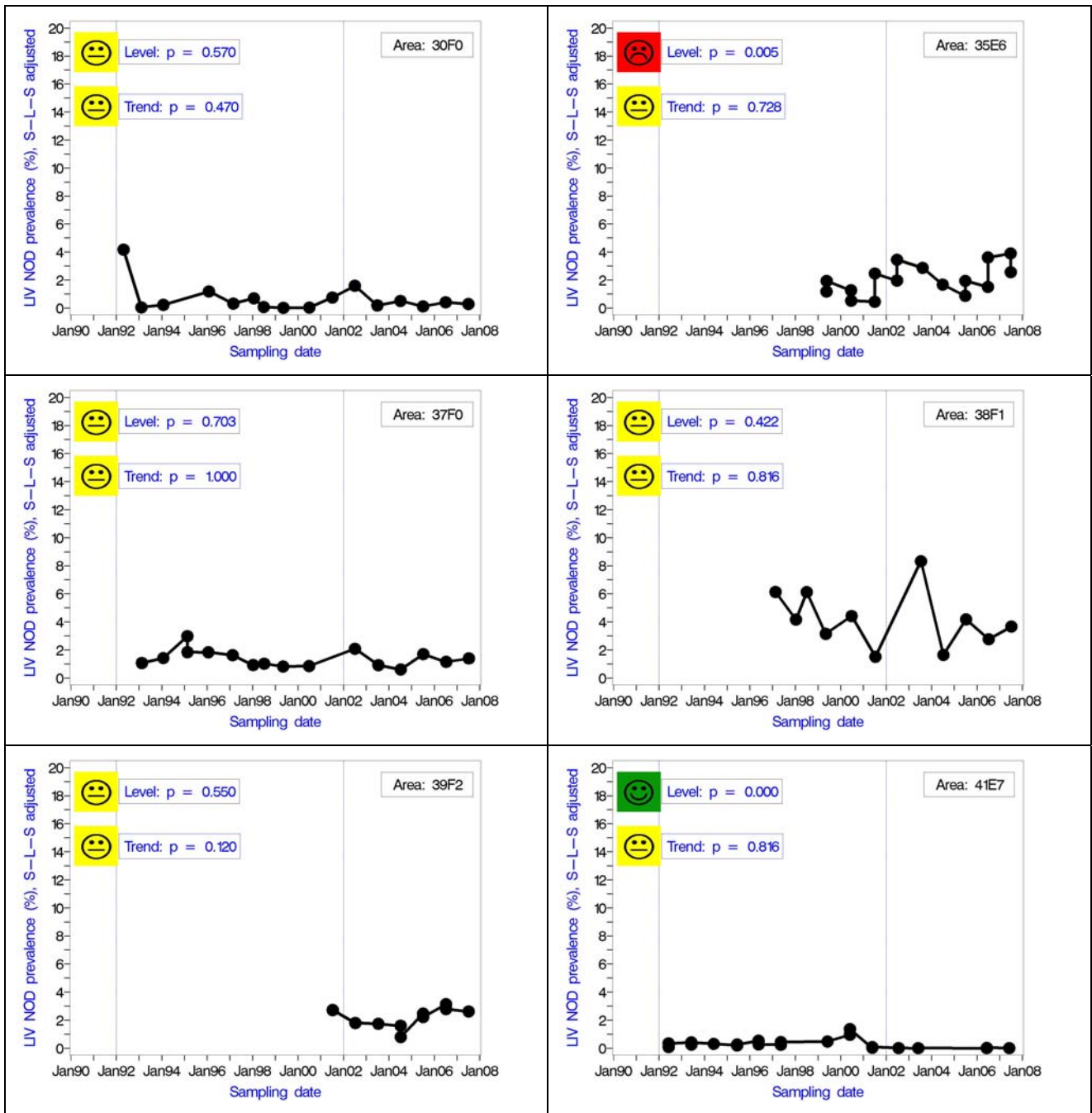
Figure 1.5.5.10. Changes in the mean FDIs for externally visible diseases (EVD) of dab (*Limanda. limanda*) according to ICES statistical rectangles in the periods 1992–2001 (learning phase) and 2002–2007 (assessment phase). All sampling points cannot be visually distinguished in this figure; however the minimum data requirements are fulfilled. "Smiley faces" indicate the significance and direction of level and trend data.

Figure 1.5.5.10 (cont.). Changes in the mean FDI for externally visible diseases (EVD) of dab (*Limanda. limanda*) according to ICES statistical rectangles in the periods 1992–2001 (learning phase) and 2002–2007 (assessment phase). All sampling points cannot be visually distinguished in this figure; however the minimum data requirements are fulfilled. "Smiley faces" indicate the significance and direction of level and trend data.

Figure 1.5.5.10.2 Changes in the mean FDI for macroscopic liver nodules (MLN) of dab (*Limanda. limanda*) according to ICES statistical rectangles in the periods 1992–2001 (learning phase) and 2002–2007 (assessment phase). All sampling points cannot be visually distinguished in this figure; however the minimum data requirements are fulfilled. "Smiley faces" indicate the significance and direction of level and trend data.
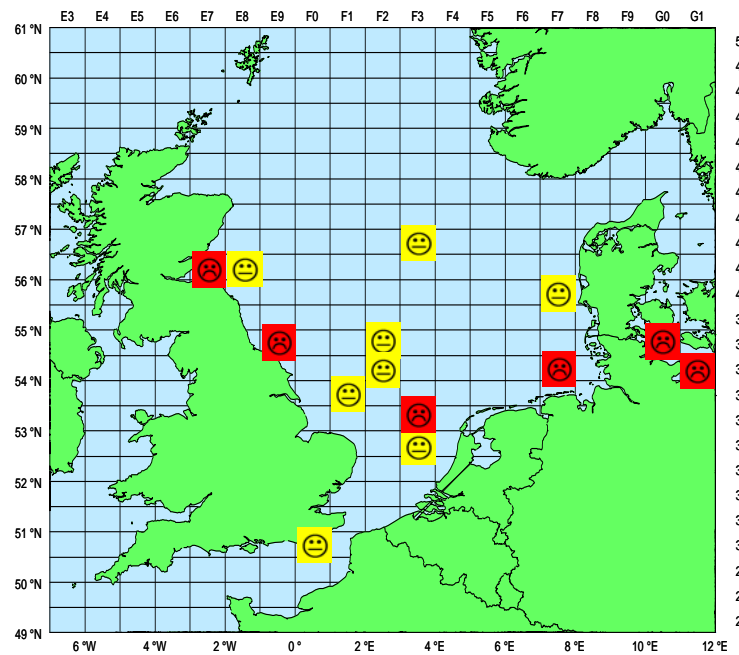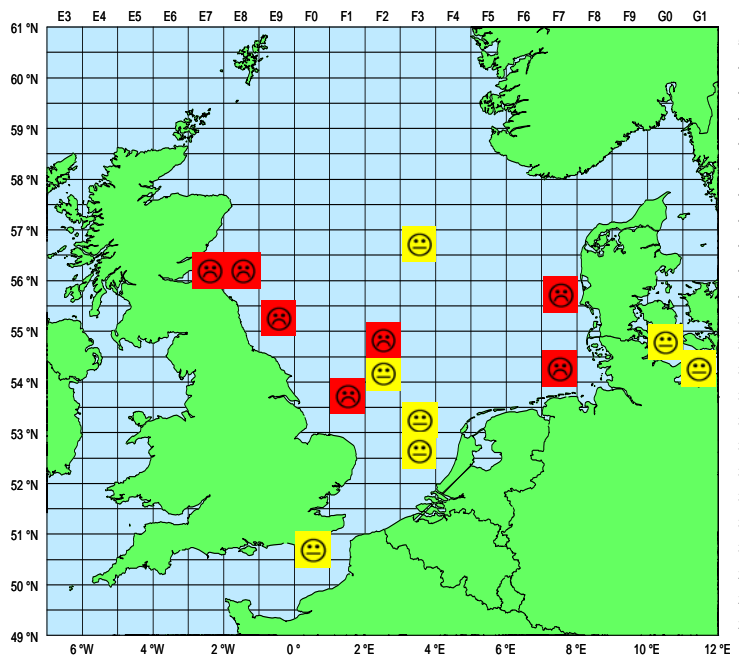
Figure 1.5.5.10.3 Results of the assessment of the Fish Disease Index values for externally visible diseases: changes in disease status of dab (*Limanda limanda*) in the North Sea in the period 2002–2007 compared to the period 1992–2001. Top figure: assessment based on FDI levels, bottom figure: assessment based on trends. Yellow indifferent faces denote no significant change; red frowny faces a significant worsening of the disease status.
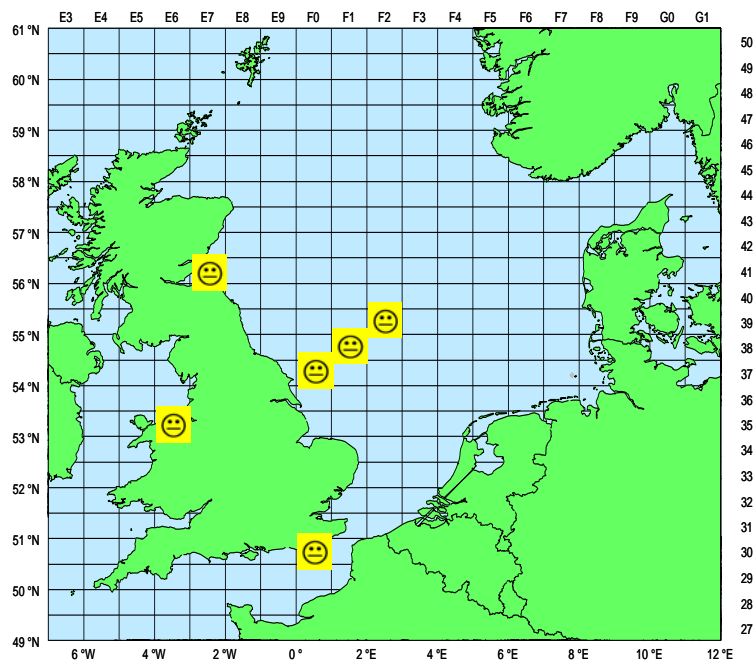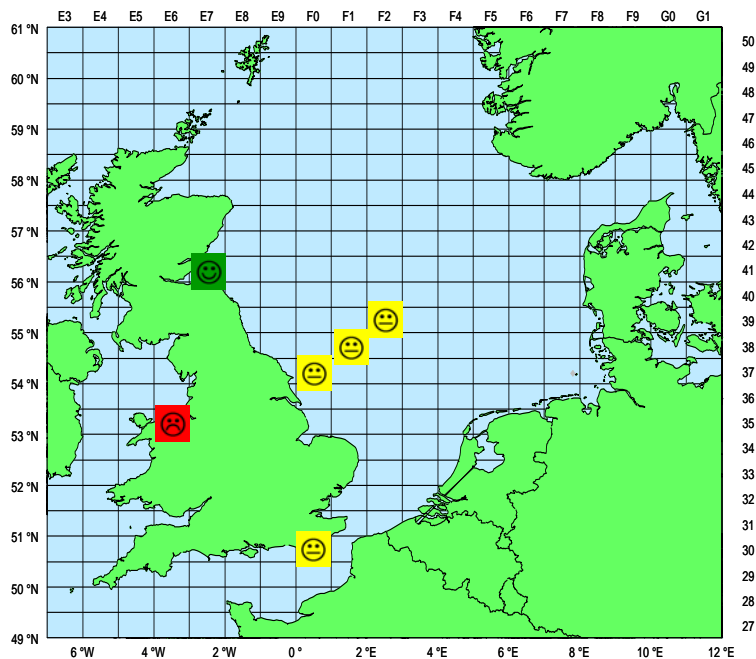
Figure 1.5.5.10.4 Results of the assessment of the Fish Disease Index values for macroscopic liver neoplasms: changes in disease status of dab (*Limanda limanda*) in the North Sea in the period 2002–2007 compared to the period 1992–2001. Top figure: assessment based on FDI levels, bottom figure: assessment based on trends. Yellow indifferent faces denote no significant change; red frowny faces a significant worsening of the disease status. Areas outside the map are located in the western Baltic Sea.

Conclusion

This assessment revealed that for the limited area for which data was available there was a general pattern indicating a worsening of the disease status in the assessment period 2002–2007, relative to the 1992–2001 period. For externally visible diseases, 10 of the 14 ICES statistical triangles assessed were characterized by a worsening of disease status, either in level (i.e., increased mean FDI for 2002–2007 as compared to mean FDI for 1992–2001), trend (significant pattern of increasing FDI values over the years 2002–2007, or both. For macroscopic liver neoplasms, only one rectangle showed an improvement in level of FDI. This worsening of the disease status of dab in the majority of geographical areas assessed should be considered an alarm bell to stimulate more research on the identification of causes of this phenomenon.

This trial application of a Fish Disease Index to the available fish health data demonstrates the utility of this approach to assess fish health and evaluate the impact of anthropogenic stresses on fish. Based on the limited data available, it was not possible to identify any regional scale patterns or trends but it is clear that fish health in many ICES rectangles is declining. There is considerable value in national laboratories making their fish health data available to the ICES Data Centre so that the assessment can be expanded in the future. It is also clear that there are many opportunities to build upon this approach to using the fish health data. For example, more data on macroscopic liver neoplasms and liver pathology data would permit an assessment of the impact of various chemical contaminants on fish health. ICES encourages the continuation and expansion of fish health monitoring programmes, the submission of additional data, and the further development of the FDI and other approaches to using the fish health data.

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Annex 1. Data on externally visible diseases (EVD), macroscopic liver neoplasms (MLN) and liver histopathology (LH) in dab (*Limanda limanda*) submitted by laboratories in ICES Member Countries to the fish disease database of the ICES Data Centre – EcoSystemData comparing submissions up to 2008 with those up to 2009. (n = number of specimens; red label = change in number due to new data submissions and/or data error elimination, EDV = externally visible diseases; MLN = macroscopic liver neoplasms; LH = liver histopathology; green squares = full set of diseases for the FDI available; yellow squares = only selected set of diseases available, empty squares = no data available). Laboratory codes are - BFCG= vTI Institute of Fishery Ecology, Cuxhaven, Germany; ALUK = FRS Marine Laboratory, Aberdeen, UK; DOUK = Cefas, Weymouth, UK; BODC = British Oceanographic Data Centre (replacing DOUK and ALUK); DGWN = Rijkswaterstaat Dienst Getijdewateren, The Netherlands; RIVO = The Netherlands Institute for Fisheries Research; DFHU = Danish Institute for Fisheries and Marine Research

Colour codes used in the disease columns below: **G** = green square; **Y** = yellow square; blank = empty square.

Year	n Status 3/2008	n Status 2/2009	Germany BFCG EVD	BFCG MLN	BFCG LH	UK ALUK EVD	ALUK MLN	ALUK LH	UK DOUK EVD	DOUK MLN	DOUK LH	UK BODC EVD	BODC MLN	BODC LH	NL DGWN EVD	DGWN MLN	DGWN LH	NL RIVO EVD	RIVO MLN	RIVO LH	DK DFHU EVD	DFHU MLN	DFHU LH
1981	25,590	25,590	Y																				
1982	26,810	26,810	Y																				
1983	21,305	21,305	Y																				
1984	27,750	27,750	Y															Y	Y		Y		
1985	18,652	18,652	Y																		Y		
1986	7,893	**40,618 (red)**	G															Y			Y		
1987	28,906	28,907	G															Y			Y		
1988	24,634	24,634	G															Y			Y		
1989	18,522	18,523	G															Y			Y		
1990	21,822	21,825	G															Y			Y		
1991	31,935	31,937	G			Y	Y		Y						Y	Y		Y			Y		
1992	35,211	35,213	G			Y	Y		Y						Y	Y		Y			Y		
1993	24,362	24,365	G			Y	Y		Y						Y	Y		Y			Y		
1994	9,361	**17,466 (red)**	G			Y	Y		Y						Y	Y							
1995	9,510	**20,209 (red)**	G			Y	Y		Y						Y	Y							
1996	12,152	**23,182 (red)**	G			Y	Y		Y						Y	Y							
1997	8,692	**16,151 (red)**	G			Y	Y		Y						Y	Y							
1998	17,527	**24,054 (red)**	G			Y	Y		Y									Y	Y				
1999	11,485	**13,245 (red)**	G			Y			Y														
2000	14,211	**14,593 (red)**	G			Y	Y		Y														
2001	12,920	**13,559 (red)**	G			Y	Y		Y									Y					
2002	25,449	**25,516 (red)**	G			Y	Y		Y														
2003	22,915	**25,105 (red)**	G			Y	Y		Y									Y					
2004	22,506	**27,079 (red)**	G			Y	Y		Y														
2005	**20,508 (red)**	17,835	G									Y	Y					Y					
2006	22,276	**26,464 (red)**	G									Y	Y										
2007	13,304	**24,740 (red)**	G									Y	Y										
2008	0	**9,893 (red)**	G																				
N	536,208	645,220	406,569			67,384			48,669			31,045			10,614			18,028			62,911		