

PART B: SCIENTIFIC COUNCIL MEETING 1-12 SEPTEMBER 2011

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REPORT OF SCIENTIFIC COUNCIL MEETING

1-12 September 2011

Chair: Ricardo Alpoim

Rapporteur: Neil Campbell

I. PLENARY SESSION

Noting the concerns expressed by the Chair of Fisheries Commission at the NAFO Annual Meeting, September 2010, regarding the timing of availability for advice on shrimp stocks, the Scientific Council met by correspondence via SharePoint and WebEx video conference during 1-12 September 2011 to address the Fisheries Commission requests and update advice on NAFO Div. 3LN and Div. 3M shrimp stocks for 2012. Representatives and participants attended from Canada, European Union (Estonia, Portugal and Spain) and Norway. The Scientific Council Coordinator was in attendance. Although only two NAFO stocks were under discussion, ICES members of NIPAG were invited by the Chair to participate in this meeting. No applications were received from observers to attend this meeting.

The provisional agenda was circulated to Contracting Parties by email on 20 July 2011 and posted on the SharePoint site. The report for this meeting was developed throughout the course of the meeting and was available on the SharePoint report area for comment.

The SharePoint site for this meeting was opened on 1 September 2011. Access to the SharePoint site, and hence participation in the meeting, was given to members of Scientific Council Executive and Members nominated by Contracting Parties. The Chair asked Representatives to post any comments on the agenda by 5 September. Participants were also asked to upload relevant documents to the SharePoint site and to discuss these documents on the discussion area. The opening session of the WebEx meeting of Council was called to order on at 0900 ADT on 9 September 2011. The report was adopted on 13 September 2011

The Chair welcomed all participants to this meeting by correspondence, noted this was the second time Scientific Council had convened in this manner and expressed his hopes that this form of meeting does not jeopardize the discussion and agreement that Scientific Council has in its' meetings of a more traditional form.

The Agenda, List of Research (SCR) and Summary (SCS) Documents, and the List of Representatives, Advisers and Experts, are given in Appendices III, IV and V, respectively.

II. FISHERIES SCIENCE

The Council adopted the Report of the Standing Committee on Fisheries Science (STACFIS) as presented by the Chair, Joanne Morgan. The full report of STACFIS is in Appendix I.

III. SPECIAL REQUESTS FROM THE FISHERIES COMMISSION

1. From September 2010

a) Update on Advice for Northern Shrimp In Div. 3M (Item 1)

The Fisheries Commission with the concurrence of the Coastal State as regards to the stocks below which occur within its jurisdiction ("Fisheries Commission") requests that the Scientific Council provide advice in advance of the 2011 Annual Meeting, for the management of Northern shrimp in Div. 3M, 3LNO in 2012.

Noting that Scientific Council will meet in October of 2010 for 2012 TAC advice, Fisheries Commission requests the Scientific Council to update its advice on shrimp stocks in 2011 for 2012 TAC.

Fisheries Commission further requests that SC provide advice in accordance to Annex 1.

Northern Shrimp in Div. 3M

Background: The shrimp fishery in Div. 3M began in 1993. Initial catch rates were favourable and, shortly thereafter, vessels from several nations joined. The number of vessels participating in the fishery has decreased by more than 60% since 2004 to 13 vessels.

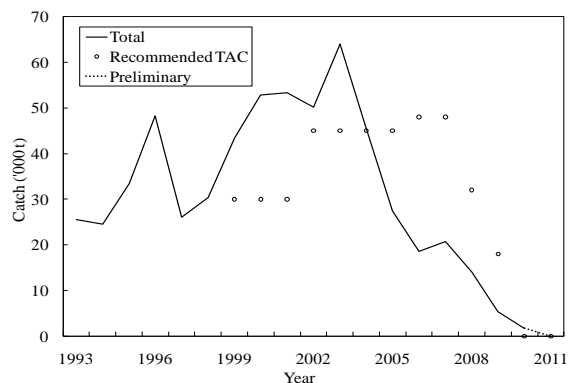
Fishery and catches: The stock is under effort regulation. The effort allocations were reduced to 50% in 2010 and there was no directed fishing in 2011 (moratorium for 2011). Catches are expected to decline close to zero in 2011. Recent catches were as follows:

Year	Catch ('000 t)		TAC ('000 t)	Effort ² (days)
	STACFIS	21A	Recommended	Agreed
2006	18	15.2	48	10555
2007	21	17.6	48	10555
2008	13	13.4	17-32	10555
2009	5	5.3	18-27	10555
2010	2	1.9	ndf	5277
2011	0 ¹		ndf	0

¹ Preliminary to September, 2011

² Effort regulated

ndf - no directed fishery

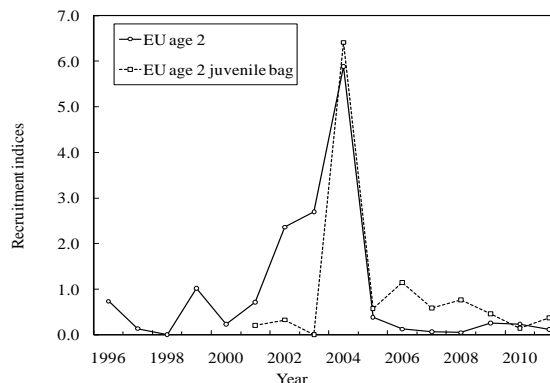


Data: Catch, effort and biological data were available from several Contracting Parties. Time series of size and sex composition data were available mainly from two countries between 1993 and 2005 and survey indices were available from EU research surveys (1988-2011). Catch data were updated for 2010. Reliable catch and effort data were not available for 2010 and there is no directed fishing for 2011. Therefore the standardized CPUE series was not updated to 2010.

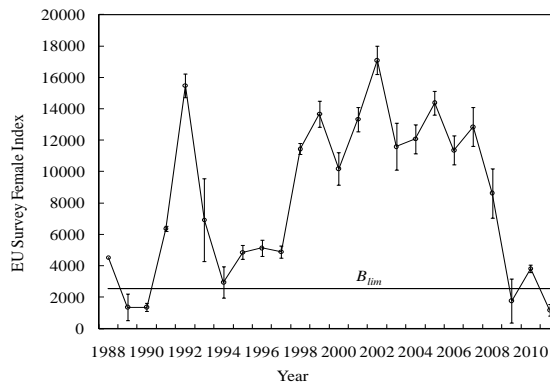
Assessment: No analytical assessment is available and fishing mortality is unknown. Evaluation of stock

status is based upon interpretation of commercial fishery and research survey data.

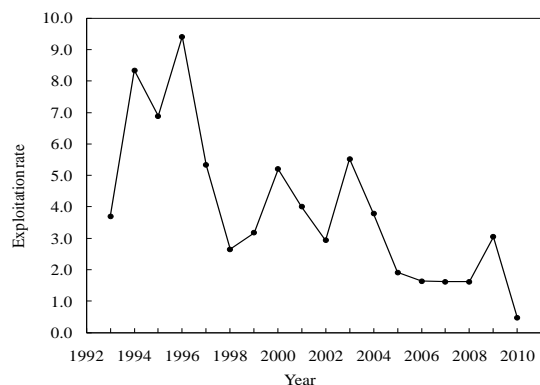
Recruitment: All year-classes after the 2002 cohort (i.e. age 2 in 2004) have been weak.



SSB: The survey index of female biomass increased from 1997 to 1998 and fluctuated without trend between 1998 and 2007. Since 2007 the survey index decreased and in 2011 it was the lowest in the survey series, well below B_{lim} .

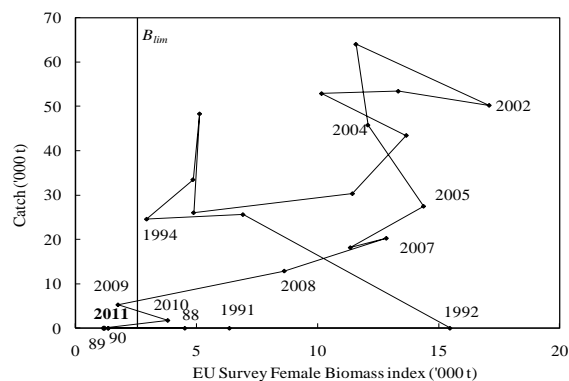


Exploitation rate: From 2005 to 2008 exploitation rates (nominal catch divided by the EU survey biomass index of the same year) remained stable at relatively low values and increased in 2009 due to low levels of the stock estimated from the EU survey that year. The low catches recorded in 2010 caused the decline of the exploitation rate to the lowest levels (0.5).



Sources of Information: SCR Doc. 11/045

State of the Stock: In 2009 the female biomass was below B_{lim} , increasing slightly above B_{lim} in 2010 and it was again well below B_{lim} in 2011. Due to the continued poor recruitment, there are serious concerns that the stock will remain at low levels.



Reference Points: Scientific Council considers that the point at which a valid index of stock size has declined by 85% from the maximum observed index level provides a proxy for B_{lim} , for Div. 3M shrimp, 2 600 t of female survey biomass. The female biomass index was below B_{lim} in 2009, it was slightly above it in 2010 and it is again well below B_{lim} in 2011. It is not possible to calculate a limit reference point for fishing mortality.

Recommendations: The 2011 survey biomass index indicates the stock is below the B_{lim} proxy and remains in a state of impaired recruitment. To favor future recruitment and stock recovery, Scientific Council recommends that the fishing mortality for 2012 be set as close to zero as possible.

Special comments: Scientific Council notes that there are indications of factors other than fishery that may be involved in the current decline of the stock.

The next assessment will be in October 2011.

b) Update on Advice for Northern Shrimp in Div. 3LNO (Item 1)

The Fisheries Commission with the concurrence of the Coastal State as regards to the stocks below which occur within its jurisdiction ("Fisheries Commission") requests that the Scientific Council provide advice in advance of the 2011 Annual Meeting, for the management of Northern shrimp in Div. 3M, 3LNO in 2012.

Noting that Scientific Council will meet in October of 2010 for 2012 TAC advice, Fisheries Commission requests the Scientific Council to update its advice on shrimp stocks in 2011 for 2012 TAC.

Fisheries Commission further requests that SC provide advice in accordance to Annex 1.

Northern Shrimp in Div. 3LNO

Background: Most of this stock is located in Div. 3L and exploratory fishing began there in 1993. The stock came under TAC regulation in 2000, and fishing has been restricted to Div. 3L.

Fishery and catches: Several countries participated in the fishery in 2011. The use of a sorting grid to reduce bycatches of fish is mandatory for all fleets in the fishery. Recent catches from the stock are as follows:

Year	Catch ('000 t)		TAC ('000 t)	
	NIPAG	21A	Recom- mended	Agreed
2007	24	21	22	22 ¹
2008	28	25	25	25 ¹
2009	28	26	25	30 ¹
2010	21	20	See footnote ²	30 ¹
2011	11 ³		<17 ⁴	19 ¹
2012				17 ⁵

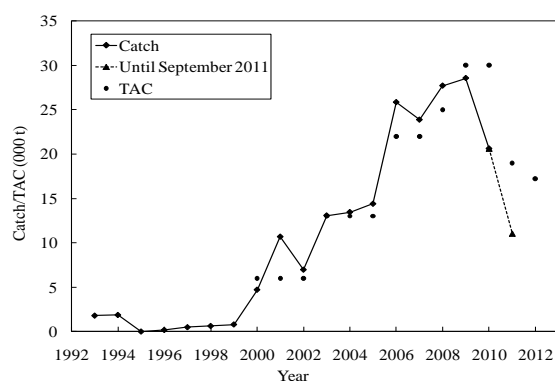
¹ Denmark (in respect of Faroes and Greenland) did not agree to the quotas of 144 t (2003–2005), 245 t (2006–2007), 278 t (2008), or 334 t (2009) and set their own quota of 1 344 t (2003–2005), 2 274 t (2006–2008) and 3 106 t (2009). The 2010 autonomous quota for Greenland was set at 532 t, while the Faroes did not set an autonomous quota for 2010. In 2011, Denmark (in respect of Greenland and Faroes) set an autonomous quota of 1 985 t. These increases are not included in the table.

² The recent exploitation rates of about 14% may be too high. Scientific Council therefore urges caution in the exploitation of the stock and considers that exploitation rates should not be raised, but kept below recent levels.

³ STACFIS estimated catches to September 2011.

⁴ In September 2010 SC considered that TAC options at 14% exploitation rate or higher to be associated with a relatively high risk of continued stock decline.

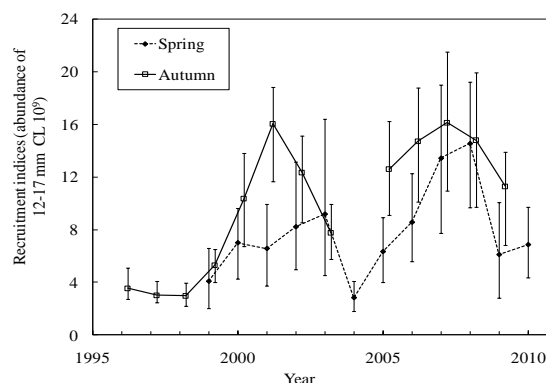
⁵ This TAC will be reviewed based on available SC advice. (FC Doc. 11/1)



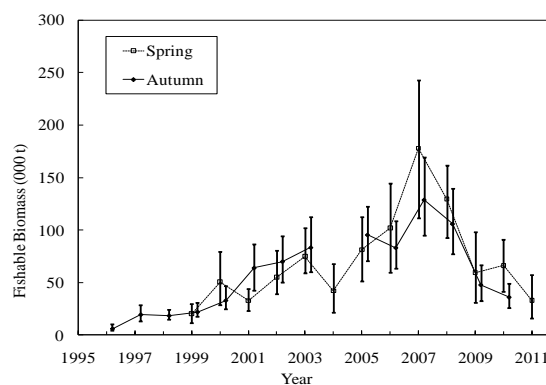
Data: Effort data were not updated. Biomass indices were available from research surveys conducted in Div. 3LNO during spring (1999 to 2011) and autumn (1996 to 2010). The Canadian survey in autumn 2004 was incomplete.

Assessment: Analytical assessment methods have not been established for this stock. Evaluation of the status of the stock is based upon interpretation of commercial fishery and research survey data.

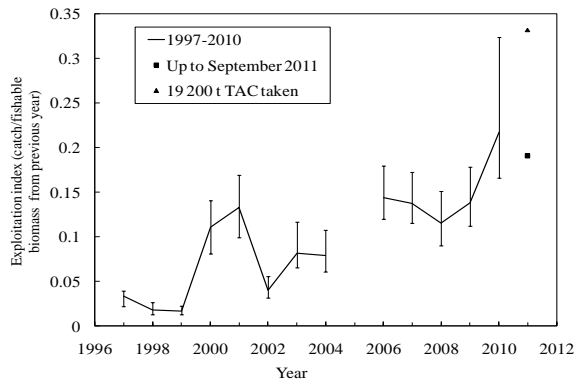
Recruitment: Recruitment indices from 2006 – 2008 were among the highest in the spring and autumn time series. The spring index decreased to near the mean in 2009 remaining near that level in 2010. The autumn recruitment index also declined in 2009. These indices were not updated.



Biomass: Spring and autumn biomass indices generally increased, to record levels by 2007, but decreased substantially by 2010. The spring biomass indices declined further in 2011.

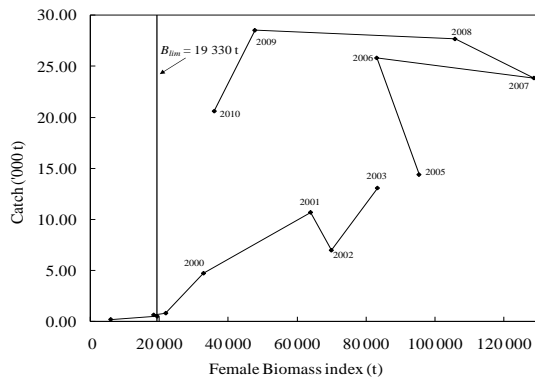


Fishing mortality: The index of exploitation has remained below 0.15 until 2009 but has since increased.



State of the Stock: Biomass levels peaked in 2007, but have since decreased substantially through to spring 2011. The female biomass index is estimated to be above B_{lim} . However, the decreased levels of biomass over the past seven consecutive Canadian surveys are a reason for concern.

Precautionary Approach Reference Points: Scientific Council considers that the point at which a valid index of stock size has declined by 85% from the maximum observed index level provides a proxy for B_{lim} (approximately 19 000 t) for northern shrimp in Div. 3LNO (SCS Doc. 04/12). Currently, the female biomass index is estimated to be above but nearing B_{lim} . It is not possible to calculate a limit reference point for fishing mortality. A safe zone has not been determined in the precautionary approach for this stock.



Recommendation: Based on the average fishable biomass the following table shows catch levels at various exploitation rates in 2012:

5.00%	3 346 t
10.00%	6 691 t
14.00%	9 367 t
25.41%	17 000 t
28.69%	19 200 t
44.84%	30 000 t

Exploitation rates over the period 2006–2009 have been near 14% and were followed by stock decline. Scientific Council considers TAC options involving exploitation rates of 14% or higher to be associated with a relatively high risk of continued stock decline. TACs lower than that will tend to reduce this risk in proportion to the reduction in the exploitation rate. Scientific Council recommended that the TAC for 2012 be less than 9 350 t. Scientific Council is not able to quantify the absolute magnitude of the risk.

Special Comment: The next assessment will be in October 2011.

Sources of Information: SCR Doc. 11/46

c) Update on PA Reference Points for shrimp in Div. 3LNO (Item 3)

*With respect to Northern shrimp (*Pandalus borealis*) in Div. 3LNO, noting the NAFO Framework for Precautionary Approach and recognizing the desire to demonstrate NAFO's commitment to applying the precautionary approach, Fisheries Commission requests the Scientific Council to:*

a) identify F_{msy}

b) identify B_{msy}

c) provide advice on the appropriate selection of an upper reference point for biomass (e.g. B_{buf})

Scientific Council responded:

This request was also addressed to Scientific Council in 2009 (NAFO *Sci. Coun. Rep.*, 2009, p 232). Scientific Council has been working to provide values for these reference points. Appropriate models have not yet been developed to a point where they have been accepted as a basis for the determination of reference points. Scientific Council is still unable to provide appropriate reference points to address this request. This request is therefore deferred to the October 2011 meeting of Scientific Council for further consideration.

d) Updates on Distribution of shrimp in Div. 3LNO (Item 4)

The Scientific Council is requested to provide updated information on the proportion of the 3LNO shrimp stock that occurs in 3NO.

Over the entire history of the Canadian surveys, at least 90% of the shrimp biomass has been recorded in Div. 3L.

Table 1. Shrimp biomass distribution in Canadian autumn surveys, 1996 – 2010.

Season	Year	Division	Biomass estimate (t)	% biomass in 3L
Autumn	1996	3L	23 056	92.71
Autumn	1997	3L	43 695	98.64
Autumn	1998	3L	56 381	92.26
Autumn	1999	3L	54 871	99.27
Autumn	2000	3L	106 519	98.88
Autumn	2001	3L	215 153	99.21
Autumn	2002	3L	189 077	97.97
Autumn	2003	3L	186 459	97.01
Autumn	2004	3L	???	???
Autumn	2005	3L	222 704	99.37
Autumn	2006	3L	215 153	99.21
Autumn	2007	3L	273 346	98.48
Autumn	2008	3L	247 874	98.76
Autumn	2009	3L	117 594	98.65
Autumn	2010	3L	74 503	99.20

Table 2. Shrimp biomass distribution in Canadian spring surveys, 1996 – 2011.

Season	Year	Division	Biomass estimate (t)	% biomass in 3L
Spring	1999	3L	47 823	96.15
Spring	2000	3L	109 439	95.94
Spring	2001	3L	83 262	97.07
Spring	2002	3L	128 971	95.74
Spring	2003	3L	166 525	97.52
Spring	2004	3L	92 626	98.40
Spring	2005	3L	134 106	99.85
Spring	2006	3L	180 620	???
Spring	2007	3L	284 018	97.75
Spring	2008	3L	224 114	99.73
Spring	2009	3L	110 949	97.96
Spring	2010	3L	130 683	99.31
Spring	2011	3L	69 469	99.42

e) Updates on Effect of 5 000 t catch on shrimp abundance in Div. 3M (item 5)

With respect to 3M shrimp, the Scientific Council estimated in 2009 a proxy for B_{lim} as 85% decline from the maximum observed index levels, this is 2600 t of female biomass. In 2009 the Scientific Council estimated biomass to be below B_{lim} and recommended fishing mortality to be set as close to zero as possible.

In 2009 estimated catches reached 5000 t. The Fisheries Commission decided on a 50% effort reduction in 2010 and provisional estimated catches up to September 2010 reached 1000 t. In its 2010 advice, the Scientific Council estimated biomass to be above B_{lim} , but reiterated its previous advice to set fishing mortality as close to zero as possible. The Fisheries Commission requests the Scientific Council to evaluate if the current level of catches is compatible with stock recovery, given that improvements in biomass levels were observed through current level of catches.

Scientific Council responded:

The biomass estimated in 2011 was the lowest recorded in the EU survey series and well below B_{lim} . All year classes after 2002 (i.e. age 2 in 2004) have been weak and there is no signs of change in this situation.

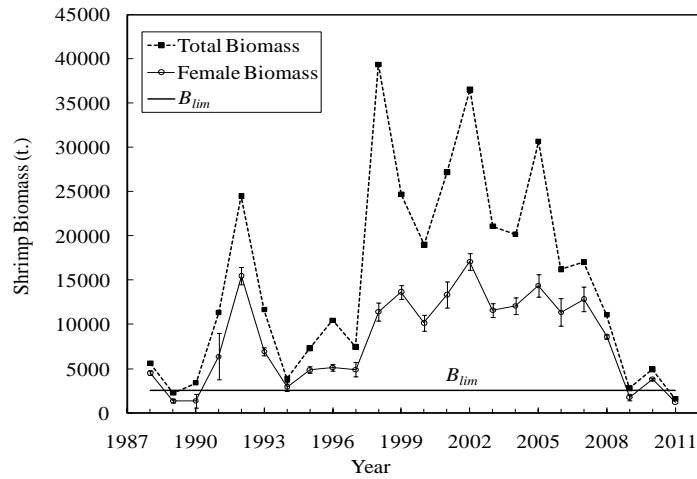


Fig. 1. Total and female biomass indexes of shrimp in EU summer survey series 1989-2011.

Catches in 2010 were around 1766 t and there was no rebuilding of the stock. In 2011 it is again in the collapsed zone. At this time there are therefore no indications that the level of catches for 2010 and zero catches for 2011 will promote stock recovery

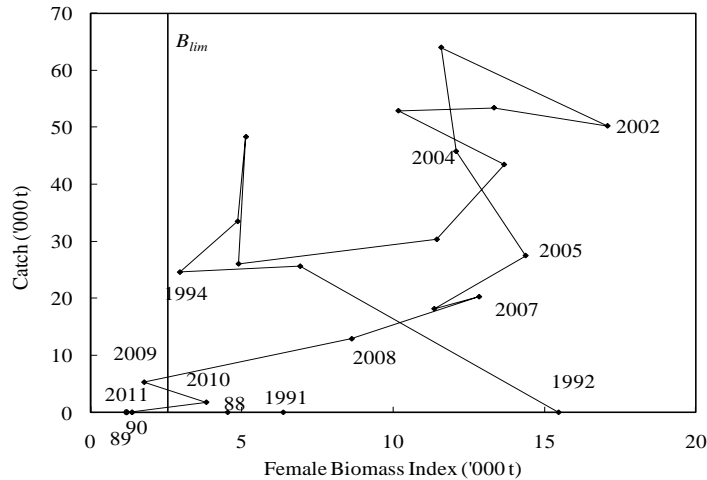


Fig. 2. Catch plotted against female biomass index from EU survey. Line denoting B_{lim} is drawn where biomass is 85% lower than the maximum point in 2002. Due to moratorium on shrimp fishery the expected catch in 2011 is 0 t.

This unflattering situation advises the maintenance of a moratorium on the shrimp fishery in Div. 3M until stock recovery signs appear.

IV. ADOPTION OF REPORT

The draft report of this meeting was circulated by email to participants and adopted. The report was adopted in full on 13 September 2011.

V. ADJOURNMENT

The meeting was adjourned by the Chair of Scientific Council after the report was adopted. Participants and the NAFO Secretariat were thanked for their contributions.

APPENDIX I. REPORT OF THE STANDING COMMITTEE ON FISHERIES SCIENCE (STACFIS)

Chair: Joanne Morgan

Rapporteur: Various

The Committee met by correspondence during 1-12 September 2011 via SharePoint and with a WebEx conference to consider the various items on its Agenda on 9 September 2011. Representatives attended from Canada, Denmark (with respect to Greenland), European Union (Estonia, Portugal and Spain) and Norway. The Scientific Council Coordinator was in attendance.

1. Opening

The Chair, Joanne Morgan, opened the meeting by welcoming participants. The provisional agenda was reviewed and adopted, and a plan of work developed for the meeting.

2. Interim Monitoring Updates

STACFIS was asked to update the assessments of Northern shrimp in Div. 3M and Northern shrimp in Div. 3LNO that had been reviewed at the meeting of NIPAG in October 2010.

a) Northern Shrimp (*Pandalus borealis*) in Div. 3M

(SCR 11/45)

Interim Monitoring Report

a) Introduction

The fishery on this stock is managed by effort regulation. Full assessments of this stock are based on the review of series of indices of survey biomass, CPUE, recruitment potential (numbers at age 2), and catch. All year classes after 2002 have been weak. The indices of female biomass in the July 2009-2011 surveys indicated a sharp decline and that the stock was below B_{lim} in 2009 and 2011 *i.e.*, had entered the collapse zone defined by the NAFO PA framework. Scientific Council recommended in October 2010 that the fishing mortality be set as close to zero as possible in 2011 and 2012. In 2011 there was no directed fishing on shrimp in Div. 3M stock.

Updated catches in 2010 were 1 766 t. In 2011 there were no catches due to the moratorium.

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Recommended TAC	45 000	45 000	45 000	48 000	48 000	17 000-32 000 ¹	18 000-27 000 ²	0	0
STATLANT 21	62 761	45 842	27 651	15 191	17 642	11 671	5 374	1 975	0 ³
NIPAG	63 970	45 757	27 479	18 162	20 741	12 889	5 429	1 766	

¹ SC recommended that exploitation level for 2008 should not exceed the 2005 and 2006 levels (17 000 to 32 000 t).

² SC recommended that exploitation level for 2009 should not exceed levels that have occurred since 2005 (18 000 to 27 000 t).

³ Preliminary catches from circular letters, to September 2011.

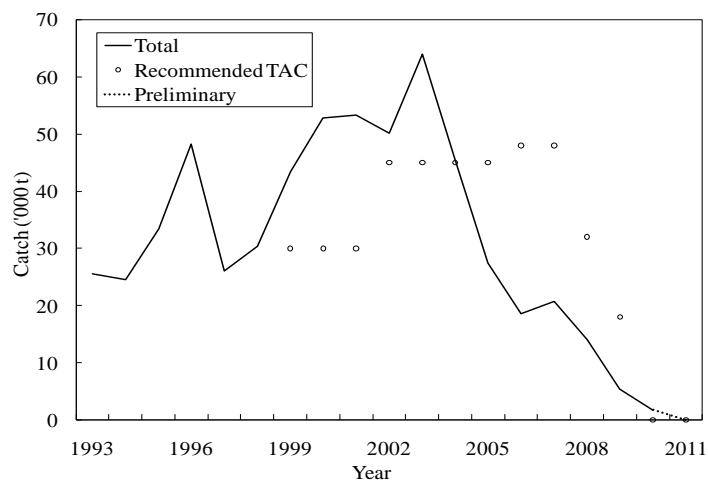


Fig. 1.1. Northern Shrimp in Div. 3M: Trends in catch (t) and TAC recommended over the period 1993-2011.

b) Data

The interim monitoring report was based on updates of total and female survey biomass, and recruitment indices with 2011 values. Surveys use a Lofoten trawl with 35-mm codend mesh, but fitted with a juvenile bag with 10-mm mesh.

c) Results

CPUE data. CPUE data was not updated at this time.

Research survey data. The survey index of female and total biomass increased from 1997 to 1998 and fluctuated without trend between 1998 and 2007. Since 2007 the survey indexes decreased and in 2011 they were the lowest in the survey series, well below B_{lim} .

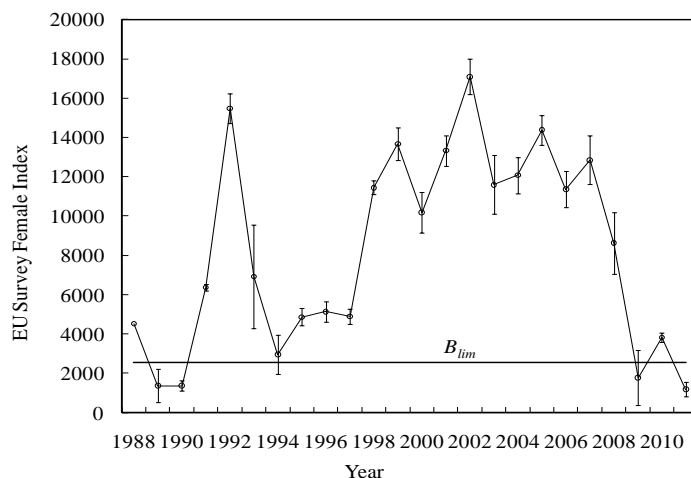


Fig. 1.2. Northern Shrimp in Division 3M: EU Survey index of female biomass, 1988 – 2011.

Recruitment: All year classes after the 2002 cohort (i.e. age 2 in 2004) have been weak.

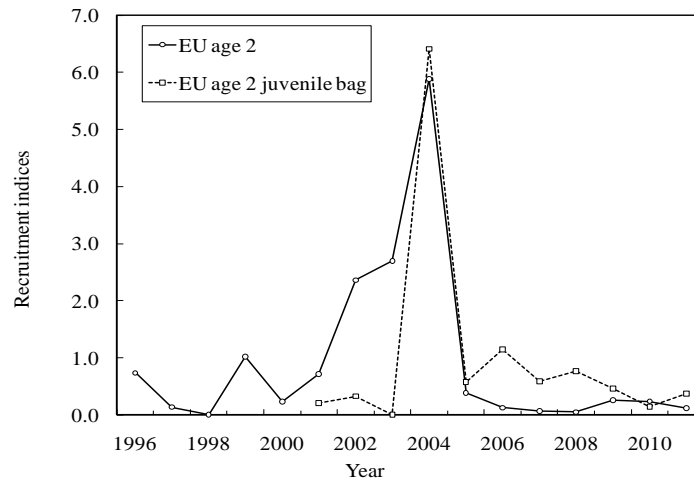


Fig. 1.3. Northern Shrimp in Division 3M: Abundance indexes at age 2 obtained in EU Flemish Cap surveys from Lofoten gear (black line) and Juvenile bag (dotted line). Each series was standardized to its mean.

Exploitation Rate: From 2005 to 2008 exploitation rates (nominal catch divided by the EU survey biomass index of the same year) remained stable at relatively low values and increased in 2009 due to low levels of the stock estimated from the UE survey that year. The low catches recorded in 2010 caused the decline of the exploitation rate to the lowest levels (0.5).

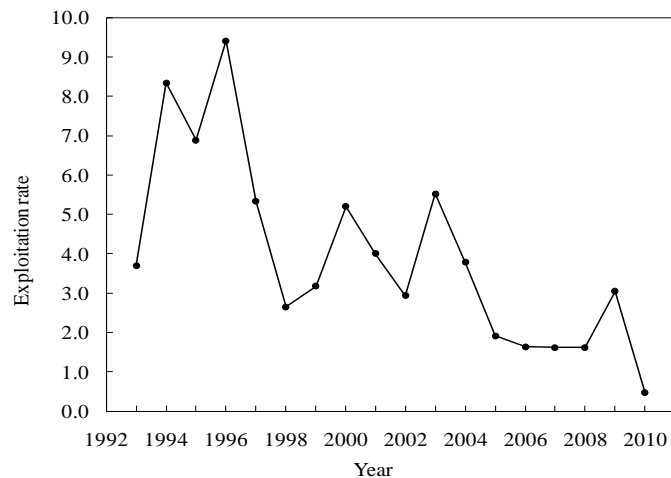


Figure 1.4. Exploitation rates as nominal catch divided by the EU survey biomass index of the same year.

Reference Points: Scientific Council considers that the point at which a valid index of stock size has declined by 85% from the maximum observed index level provides a proxy for B_{lim} , for Div. 3M shrimp, 2 600 t of female survey biomass. The female biomass index was below B_{lim} in 2009, it was slightly above it in 2010 and it is again well below B_{lim} in 2011. It is not possible to calculate a limit reference point for fishing mortality.

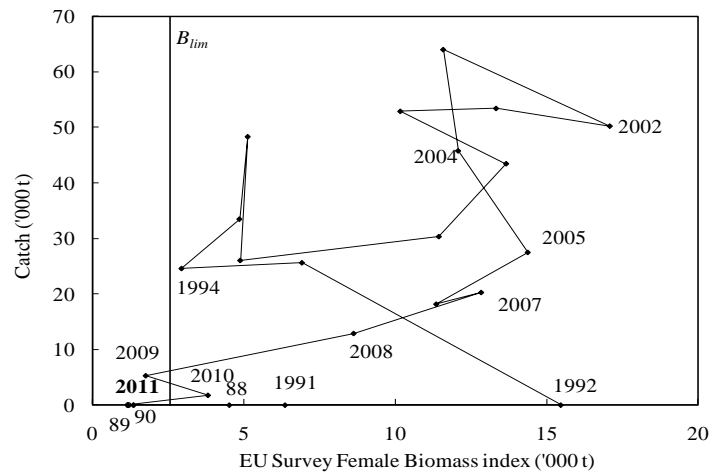


Fig. 1.5. Northern Shrimp in Division 3M: Catch plotted against female biomass index from EU survey. Line denoting B_{lim} is drawn where biomass is 85% lower than the maximum point in 2002. Due to moratorium on shrimp fishery the expected catch in 2011 is 0 t.

Ecosystem considerations: The decline of shrimp biomass in recent years is likely associated with the increase of the cod stock experienced in the last years.

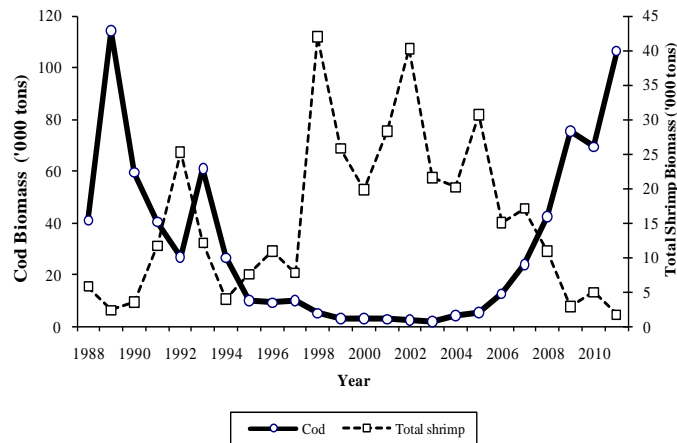


Fig. 1.6. Northern Shrimp in Division 3M: EU survey cod biomass (gross solid line) and total shrimp biomass (dashed line) in the years 1988-2011 on Flemish Cap.

STACFIS concluded that the information available does not change the perception of a significant decline in stock biomass and the stock is below B_{lim} . Due to continued low recruitment there are serious concerns that the stock will remain at low levels.

b) Northern Shrimp (*Pandalus borealis*) in Div. 3LNO

(SCR Doc. 11/46)

a) Introduction

This shrimp stock is distributed around the edge of the Grand Bank mainly in Div. 3L. The fishery began in 1993 and came under TAC control in 2000 with a 6000 t TAC and fishing restricted to Div. 3L. Annual TACs were raised several times between 2000 and 2009 reaching a level of 30 000 t for 2009 and 2010 before decreasing to 19 200 t in 2011 and 17 000 t in 2012. A total catch of 11 041 t was taken up to September 2011 (Fig. 2.1).

Recent catches and TACs (t) for shrimp in Div. 3LNO (total) are as follows:

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
TAC as set by FC	13 000 ¹	13 000 ¹	13 000 ¹	22 000 ¹	22 000 ¹	25 000 ¹	30 000 ¹	30 000 ¹	19 200	17 000 ³
STAT-LANT 21	11 917	12 051	13 574	21 284	21 120	24 758	25 621	19 726		
NIPAG	13 069	13 452	14 389	25 831	23 859	27 691	28 544	20 612	11 041 ²	

¹ Denmark (in respect of Faroes and Greenland) did not agree to the quotas of 144 t (2003–2005), 245 t (2006–2007), 278 t (2008), or 334 t (2009) and set their own quota of 1 344 t (2003–2005), 2 274 t (2006–2008) and 3 106 t (2009). The 2010 autonomous quota for Greenland was set at 532 t, while the Faroes did not set an autonomous quota for 2010. In 2011, Denmark (in respect of Greenland and Faroes) set an autonomous quota of 1 985 t. These increases are not included in the table.

² STACFIS estimated catches to September 2011.

³ For 2012 TAC will be reduced to 17 000 t. This TAC will be reviewed based on available SC advice. (FC Doc. 11/1)

Since this stock came under TAC regulation, Canada has been allocated 83% of the TAC. This allocation is split between a small-vessel (less than 500 GT and less than 65 ft) and a large-vessel fleet. By September 2011, the small- and large-vessel fleets had taken 6 388 t and 2 423 t of shrimp respectively in Div. 3L. In all years, most of the Canadian catch occurred along the northeast slope in Div. 3L. The annual quota within the NAFO Regulatory Area (NRA) is 17% of the total TAC.

The use of a sorting grid to reduce bycatches of fish is mandatory for all fleets in the fishery. The sorting grid cannot have a bar spacing greater than 22 mm.

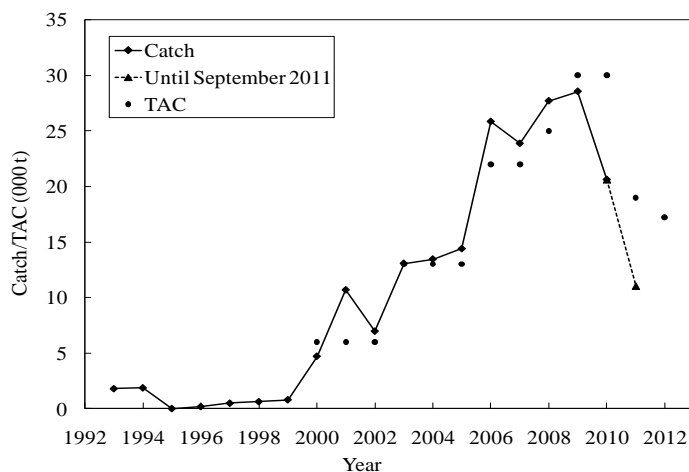


Fig. 2.1. Northern Shrimp in Div. 3LNO: catches (to September 2011) and TAC as set by Fisheries Commission.

b) Input Data

i) Commercial fishery data

Effort and CPUE. No updated information at this time.

Catch composition. No updated information at this time.

ii) Research survey data

Canadian multi-species trawl survey. Canada has conducted stratified-random surveys in Div. 3LNO, using a Campelen 1800 shrimp trawl, from which shrimp data is available for spring (1999–2011) and autumn (1996–2010). The autumn survey in 2004 was incomplete and therefore of limited use for the assessment.

Spanish multi-species trawl survey. No updated information at this time.

Biomass. In Canadian surveys, over 90% of the biomass was found in Div. 3L, distributed mainly along the northeast slope in depths from 185 to 550 m. There was an overall increase in the both spring and autumn indices to 2007 after which they decreased by about 75% to 2011 (Fig. 2.2). Confidence intervals from the spring surveys are usually broader than from the autumn surveys.

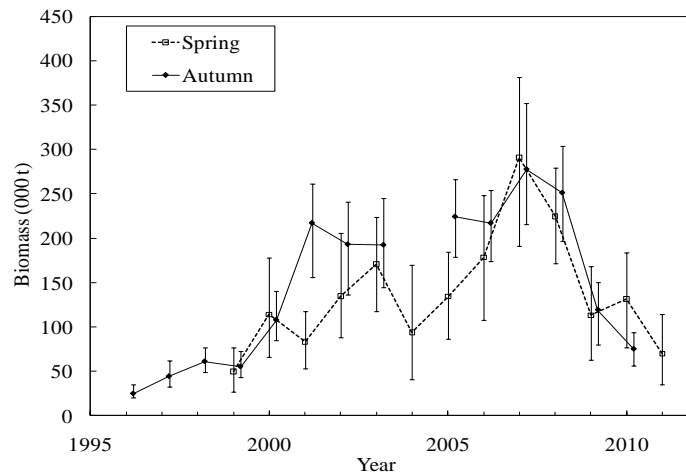


Fig. 2.2. Northern Shrimp in Div. 3LNO: biomass index estimates from Canadian spring and autumn multi-species surveys (with 95% confidence intervals).

Stock composition. No updated information at this time.

Female Biomass (SSB) indices. The autumn Div. 3LNO female biomass index showed an increasing trend to 2007 but decreased 72% by 2010. The spring SSB index decreased by 82% between 2007 and 2011 (Fig. 2.3).

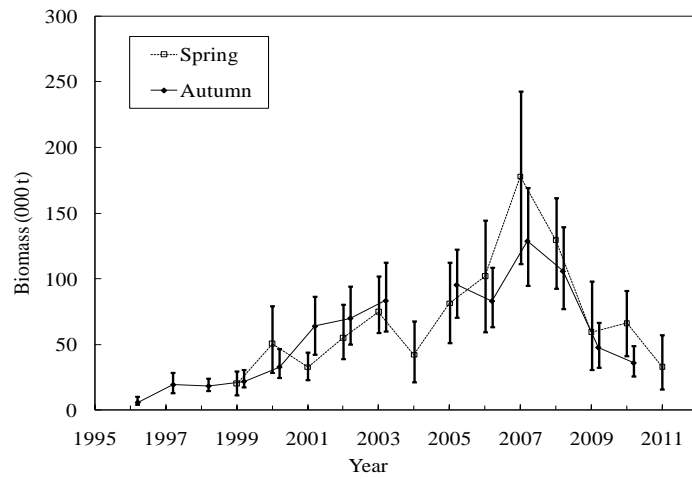


Fig. 2.3. Northern Shrimp in Div. 3LNO: Female biomass indices from Canadian spring and autumn multi-species surveys (with 95% confidence intervals).

Recruitment indices. No updated information at this time.

Fishable biomass and exploitation indices. There had been an increasing trend in Canadian spring and autumn survey fishable biomass indices (shrimp >17 mm carapace length) until 2007. The autumn fishable biomass showed an increasing trend until 2007 then decreased by 76% through to 2010. Similarly, the spring fishable biomass index increased to 2007 but has since decreased by 79 % through to 2011 (Fig. 2.4).

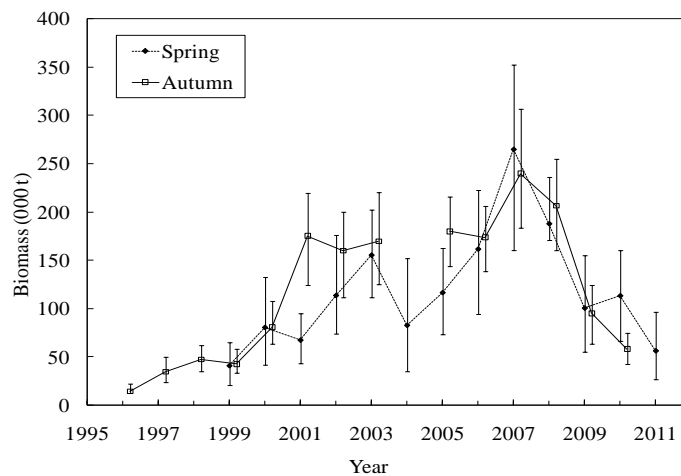


Fig. 2.4. Shrimp in Div. 3LNO: fishable biomass index. Bars indicate 95% confidence limits.

An index of exploitation was derived by dividing the catch in a given year by the fishable biomass index from the previous autumn survey. The catch series was updated in the 2011 analysis. The exploitation index has been below 0.15 until 2010 when it increased to 0.22. By September 2011, the 2011 exploitation rate index was 0.19. Based upon the autumn 2010 fishable biomass of 57 900 t, if the entire 19 200 t quota was to be taken, the exploitation rate index would increase to 0.33 (Fig. 2.5).

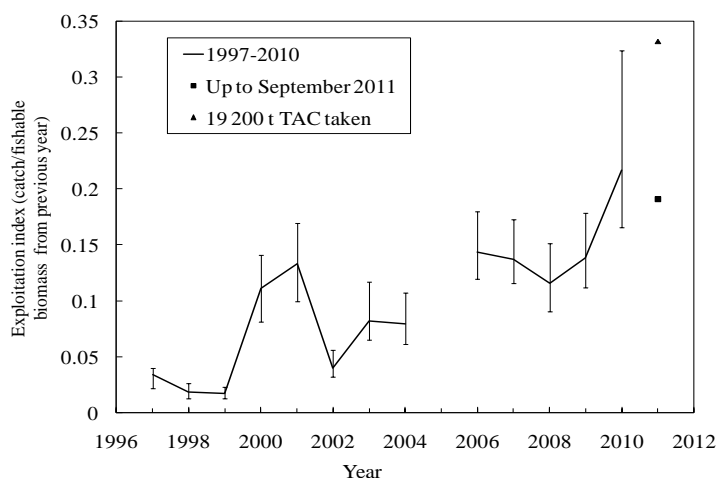


Fig. 2.5. Shrimp in Div. 3LNO: exploitation rates calculated as year's catch divided by the previous year's autumn fishable biomass index. The 2011 exploitation rate index is based upon incomplete catch data. Bars indicate 95% confidence limits.

c) Assessment Results

Recruitment. Recruitment indices from 2006-2008 were among the highest in the spring and autumn time series. The spring index decreased to near the mean in 2009, remaining near that level in 2010. The autumn recruitment index also declined in 2009. There was no updated information at this time.

Biomass. Spring and autumn biomass indices generally increased, to record levels by 2007, but decreased substantially by 2010. The spring biomass indices declined further in 2011.

Exploitation. The index of exploitation has remained below 0.15 until 2009 but has since increased.

State of the Stock. Biomass levels peaked in 2007, but have since decreased substantially through to spring 2011. The female biomass index is estimated to be above B_{lim} . However, the decreased levels of biomass over the past seven consecutive Canadian surveys are a reason for concern.

Inverse variance weighted average fishable biomass was calculated from the four most recent Canadian research surveys into 3LNO.

Variance weighting factor = fishable biomass/(measure of variance)² ÷ Σ fishable biomass/(measure of variance)²

Survey	Fishable biomass (t)	Fishable biomass – lower 95% C.I.= measure of variance	Fishable biomass/(measure of variance ²)	1/measure of variance ²	Variance weighting factor
Autumn 2009	95 042	31 301	9.70035E-05	1.02E-09	0.150
Spring 2010	113 366	47 108	5.10845E-05	4.51E-10	0.067
Autumn 2010	57 891	15 464	0.000242071	4.18E-09	0.617
Spring 2011	56 280	29 852	6.31567E-05	1.12E-09	0.166
Grand total			4.53315E-04	6.775E-09	1.00

$$\text{Inverse variance weighted average fishable biomass} = \frac{4.53315E-04}{6.775E-09} = 66\,911 \text{ t}$$

The inverse variance weighted average fishable biomass of the four most recent surveys is calculated to be 66 911 t. Based on this value, the following table shows exploitation rates at various catch levels in 2012:

TACs options at various percent exploitation rates (catch/fishable biomass)

Inverse variance weighted average fishable biomass	5.00%	10.00%	14.00%	25.41%	28.69%
66 911 t	3 346	6 691	9 367	17 000	19 200

At TACs of 17 000 t and above, the exploitation rate is estimated to be 25% or higher, which is well beyond the range of exploitation rates previously seen in this fishery. Given recent declines in stock biomass, catches at this level are likely to result in further declines.

Exploitation rates over the period 2006 – 2008 had been near 14% and were followed by stock decline.

d) Precautionary Approach Reference Points

Scientific Council considers that the point at which a valid index of stock size has declined by 85% from the maximum observed index level provides a proxy for B_{lim} (approximately 19 000 t) for northern shrimp in Div. 3LNO (SCS Doc. 04/12). Currently, the female biomass index is estimated to be above but nearing B_{lim} (Fig. 2.6). It is not possible to calculate a limit reference point for fishing mortality. A safe zone has not been determined in the precautionary approach for this stock.

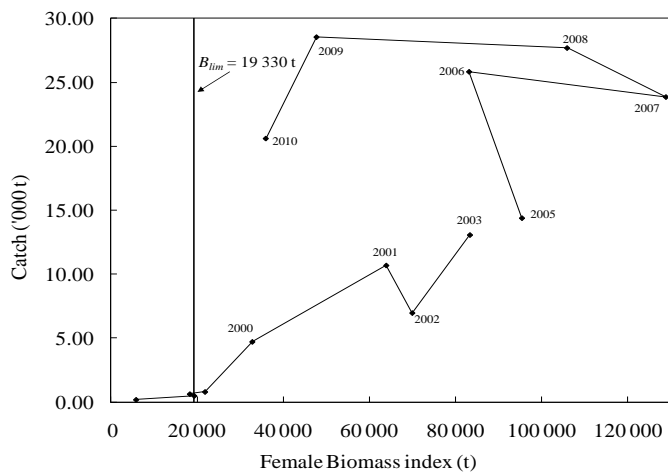


Fig. 2.6. Shrimp in Div. 3LNO: Catch against female biomass index from Canadian autumn survey. Line denoting B_{lim} (approximately 19,000 t) is drawn where female biomass is 85% lower than the maximum point in 2007.

e) Research Recommendations

STACFIS **recommended** that the biomass of Northern shrimp in Div. 3LNO be examined in relation to biomass of other species in the same area.