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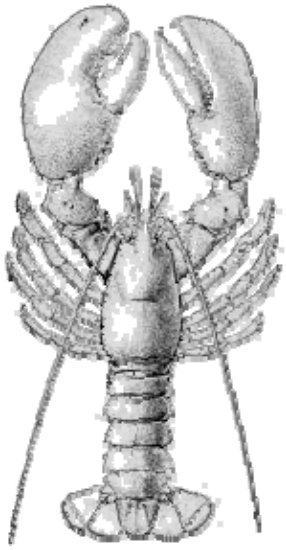
Canadian Science Advisory Secretariat
Science Advisory Report 2011/064

ASSESSMENT OF LOBSTER OFF THE ATLANTIC COAST OF NOVA SCOTIA (LFAS 27-33)



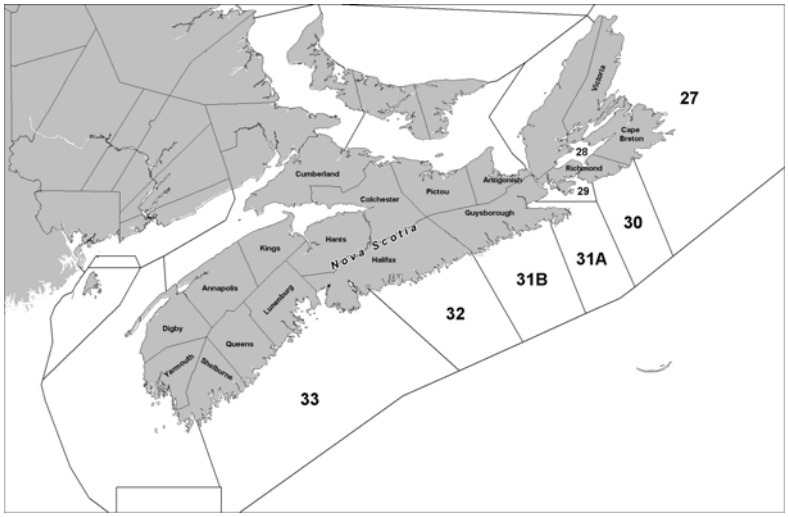


Figure 1. Lobster Fishing Areas (LFAs) 27-33.

Context :

Lobsters (Homarus americanus) are found in coastal waters from southern Labrador to Maryland, with some major fisheries in the Canadian Maritimes. Lobster Fishing Areas (LFAs) 27-33 stretch from the northern tip of Cape Breton Island to Barrington Bay (Shelburne County) in the south. Geographic areas associated with LFAs 27-33 are Eastern Cape Breton, the Eastern Shore and the South Shore of Nova Scotia. Although the LFAs extend out to 92 km (50 nautical miles), colder water temperatures with increasing depth generally limit fishing to within 5 km of shore in northern Cape Breton and to within 20 km from shore in the south.

The status of the lobster resources in LFAs 27-33 was last assessed in 2004. Fisheries Management has requested updated information on the status of the LFA 27-33 lobster stocks. A framework meeting was held from February 1-3, 2011, to establish the scientific basis for the provision of management advice for these stocks.

This Report is from a Science Advisory Process held on July 21-22, 2011, to assess the status of lobster stocks in LFAs 27-33. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

SUMMARY

General

- Three stock assessment units were defined based on cluster analysis of historical landings of Statistical Districts (smaller than LFAs): LFA 27, LFAs 28-32 and LFA 33. Recent trends

(last 10-12 years) within the assessment units have not been identical, and where appropriate, analysis at subunit levels is provided.
- Landings are the only available proxy for lobster abundance that has a time series greater than 20 years.
- In more recent years, the main abundance trends for all assessment units come from catch per unit effort (CPUE) expressed in numbers per trap haul (N/TH) or weight per trap haul (kg/TH). CPUE is related to abundance but is affected by a variety of factors.
- Where CPUE has been standardized with a model, it is referred to as an index or indices. Unstandardized CPUEs are annual means.
- Unstandardized CPUE from mandatory logs corresponds well with unstandardized CPUE from voluntary logs (longer time series, fewer participants) where the two data types overlap.
- An index of exploitation rate (ER) has been stable or declined slightly in all assessment units. It is concluded that the current levels of exploitation do not threaten sustainability in any of the assessment units under current environmental conditions.
- Size at onset of maturity (SOM) was estimated for 3 locations in Cape Breton from 2006-2008. SOM estimates varied annually, spatially and seasonally. The percent mature at the minimum legal size (MLS) ranged from 77-100%.
- SOM estimates are not yet available for sites in LFA 31A, 32 and 33, but evidence suggests a spatial trend of increasing SOM going from LFA 31A to LFA 33.
- Preliminary estimates of bycatch and discards for the lobster fishery in LFAs 27-33 are available for the first time. The proportion of the non-targeted bycatch varies from 0.1% in LFA 32 to 7.5% in LFA 33. There were low occurrences of species listed under the *Species at Risk Act* (*SARA*). Sublegal lobsters represent the majority of discards.

LFA 27

- Indicators of stock health for lobsters in LFA 27 overall are positive.
- Landings in 2010 in LFA 27 (2,568 t) and the mean for the last 3 years (2,532 t) were above the median for 1985-2004 (1996).
- Effort as indicated by days fished (2002-2010) and total trap hauls (2004-2010) was stable or without trend.
- Unstandardized commercial CPUE from available logs in LFA 27 has trended upwards since 2002.
- LFA 27 abundance indicators for sublegals and legal sizes based on standard traps deployed by the Fishermen and Scientists Research Society (FSRS) are positive overall. A CPUE index for sublegals increased from 1999 to 2010 and the mean of the last 3 years is above the median for 1999-2007. A CPUE index for legal sizes fluctuated without trend but the mean for 2008-2010 is above the median for 1999-2007.
- Unstandardized CPUE for ovigerous females in FSRS traps is up from 1999, as is the unstandardized CPUE of ovigerous females in voluntary fishing logs and the unstandardized CPUE from at-sea samples in a port in the northern portion of LFA 27.
- The increase in unstandardized CPUE of ovigerous females and sublegals is consistent with the expectations from the increase in Minimum Legal Size (MLS) in LFA 27 from 70 to 76 mm Carapace Length (CL) (1998-2002) and from 76 to 81 mm CL (2007-2009).
- The exploitation rate index (0.77, mean of last 3 years) is close to the median for the 1999-2007 period (0.76). An index of ER that accounts for the increases in MLS from 2007 to 2009 indicates that ER in LFA 27 was approximately 30% lower once the current MLS was reached.

LFAs 28-32

- Indicators of stock health for lobsters in LFAs 28-32 overall are mainly positive.
- Landings in 2010 in LFAs 28-32 (3,866 t) and the mean for the last 3 years (4,224 t) were well above the median for 1985-2004 (822 t).
- In the LFA 28-32 assessment unit, reported effort increased from 2005 to 2009 and decreased in 2010. Within individual LFAs, the pattern varied.
- Unstandardized commercial CPUE from available logs in LFAs 28-32 has trended upwards since the 1990s. This trend was strongest from 2004 to 2009.
- LFA 28-32 abundance indicators for sublegals and legal sizes based on standard traps deployed by the FSRS are positive and well above levels seen in earlier periods. A CPUE index for sublegals increased substantially from 2002-2007 and declined recently, but the mean of the last 3 years is still above the median for 2000-2007.
- A CPUE index for legal sizes followed the sublegal index trend, increasing from 2004 to 2009, with the mean of the last 3 years 1.7 times the median for 2000-2007.
- An egg index for LFA 31A based on at-sea samples and the length-fecundity relationship was substantially higher in more recent years (2008-2010) compared to 2002-2003.
- The ER index for LFAs 29-32 has fluctuated with no consistent trend. Mean ER for the last 3 years (0.61) is below the median for 2000-2007 (0.70).

LFA 33

- Indicators of stock health for lobsters in LFA 33 overall are positive.
- Landings in LFA 33 for the 2009-2010 season (3,377 t) and the mean for the last 3 years (3,126 t) were above the median for 1984-1985 to 2003-2004 (2,071 t).
- Reported effort increased by 10-15% from 2001-2002 to 2007-2008, with no apparent change in the last 3 fishing seasons. The changes occurred in total days fished, mean days fished and in estimated trap hauls from mandatory logs.
- Unstandardized commercial CPUE from available logs in LFA 33 CPUE has trended upwards since the 1990s.
- LFA 33 abundance indicators for sublegals and legal sizes based on standard traps deployed by the FSRS are positive or neutral. A temperature-corrected abundance index for sublegals (76-80 mm CL) increased from 1999-2000 to 2008-2009 and the mean for the two seasons ending in spring 2009 was 1.3 times the median of the period 1999-2000 to 2006-2007. Unstandardized CPUE of sublegals in FSRS traps increased from the 2000-2001 season to the 2009-2010 season. Unstandardized CPUE of legal sizes in FSRS traps fluctuated without trend.
- Mean ER for the last 3 years (0.67) is below the median for 1999-2000 to 2006-2007 (0.76).

BACKGROUND

Management Measures

Management measures (Table 1) include closed seasons, limited licenses, trap limits, minimum legal sizes (MLS) and protection of females with eggs (ovigerous or “berried”). There is a possession restriction of V-notched lobsters except in LFA 27 and LFA 31A.

Table 1. Numbers (No.) of licenses and management measures in LFAs 27-33 as of 2010.

LFA	Season	Total No. of Licenses	Trap Limit[1]	MLS (mm)	Other Measures
27	May 15 - July 15	524	275	81	
28	April 30 - June 30	16	250	84	Max. hoop size – 153 mm
29	April 30 - June 30	67	250	84	Max. hoop size – 153 mm
30	May 20 - July 20	20	250	82.5	Max. carapace length -135mm for females
31A	April 29 - June 30	73	250	82.5	Closed window,114-124 mm
31B	April 19 - June 20	71	250	82.5	V-notching and release of 110lb of mature females/ licence
32	April 19 - June 20	161	250	82.5	V-notching, and release of 110lb of mature females/ licence
33	Last Mon. Nov - May 31	707	250	82.5	

[1] Trap limit is for category "A" licence holder. Part-time or category "B" licences are allowed 30% and Partnerships 150% the limit of a single full-time licence. CL = carapace length

There have been some significant changes in management measures in LFAs 27-33 since 1998. The largest change was an increase in the MLS in LFA 27 from 70 to 76 mm CL (1998-2002) and from 76 to 81 mm CL (2007-2009). Other LFAs have also introduced trap limit reductions. Voluntary V-notching can occur in all LFAs, but in LFA 27 and 31A, V-notched lobsters can be legally retained.

Stock Assessment Units

The rationale for stock assessment units and their delineation were detailed at the framework meeting (Feb. 1-3, 2011). Previous assessments of lobsters in LFAs 27-33 have been primarily LFA-based. The last time these stocks were assessed there were three stock status reports (Eastern Cape Breton Lobster - LFAs 27-30; Eastern Shore Lobster - LFAs 31A, 31B, 32; and South Shore Nova Scotia Lobster - LFA 33). All of the data on lobster populations in coastal Nova Scotia comes from the fishery in the individual LFAs; however, there is merit to moving towards larger units that have some basis in biology and common population trends.

A cluster analysis of historical lobster landings (1947-2009) for Statistical District (SD) was used to group LFAs for assessment purposes. The resultant groups had similar trends in landings over the last 63 years. Cluster groups resulting from an analysis with just the data from 1985-2009 were similar to those from the analysis of landings from the 63 year period.

The assessment units identified were as follows:

1. Northeastern Cape Breton (LFA 27)
2. Southeastern-Cape Breton, Chedabucto Bay and Eastern Shore (LFA 28-32)
3. South Shore (LFA 33)

Recent trends (last 10-12 years) within the assessment units have not been identical, and where appropriate, analysis at subunit levels is provided.

LFA 28 in Bras d'Or Lake is fished by few fishermen with reported landings in the range of 5-20 t over the last 20 years (11 t in 2010). Historical landings did not separate Bras d'Or Lake as a unit, so it could not be assessed in the cluster analysis. LFA 28 has been grouped with LFA 29 in the past, and this practice is continued here although there is evidence that LFA 28 is more associated with LFA 27 than LFA 29.

Two of the above assessment units were further subdivided for some analyses. LFA 27 was divided by SD (1: north, 4: northcentral, 6: central and 7: south). For some analyses, the two northern SD were combined and the two southern SD were combined. LFA 33 was divided into eastern and western subunits.

ASSESSMENT

Sources of Information

Mandatory Reporting of Landings and Effort

Landings data from 1892 are available but effort data were only available for part of the last decade. Effort in terms of number of days fished was available from logs from 2002 onwards. Data on daily trap hauls were available for a few fishermen in 2004 and 2005 during a pilot project in LFAs 27-32. A Lobster Catch and Settlement Report was introduced in 2006 (2005-2006 in LFA 33) that requires daily catch (weight) and effort (trap hauls) together with location by reference to a grid system. Introduction of third-party data entry in recent years has resulted in more timely data access.

Voluntary Reporting of Landings and Effort

From 1981 to 2010, index fishermen kept fishing logs of the weight of daily catch and the effort (number of trap hauls per day). Selection of participants was not random and was based on their willingness to contribute their information. It is assumed that annual fluctuations in the catch rates of logbook keepers reflect the fishery as a whole. A proportion of the voluntary logs also recorded daily catches of berried females.

Samples of the Commercial Catch

At-sea sampling provides detailed information on fishing location, depth, and lobster size-structure in the traps prior to any discarding, as well as data on berried, and soft-shelled lobsters. For the purposes of this assessment, size data from 1990-2010 were accessed. Port samples provide data on the size of the landed catch. Some fishing location data are also obtained.

FSRS Recruitment Traps

The Fishermen and Scientists Research Society (FSRS) recruitment trap project involves volunteer fishermen keeping track of the lobsters caught in project traps. Fishermen participants use standard traps and a standard measuring gauge and count the number of lobster per trap. As such the units of FSRS CPUE are numbers per trap haul. Temperature is recorded for one of the traps maintained by each fisherman. Participants record size (one of 15 size groups), sex, and presence of external eggs for all lobsters collected in standard traps on each day of commercial fishing. Participants in the project are distributed along the Atlantic coast of Nova Scotia.

The sizes in FSRS traps appear to be a good representation of what is captured in at-sea samples of the commercial catch. There was good agreement between the sizes sampled by FSRS traps and those sampled by at-sea samples in LFAs 27, LFA 31A and LFA 33 in the spring. In the fall period in LFA 33, the correspondence between the two data sets was not as good. During the fall, the fishery is in deeper water and thus represents a different portion of the population than the FSRS data for the same time period.

Fishery Performance

Landings

It is recognized that landings are not a very sensitive indicator of lobster abundance for reasons given below and they are included under Fishery Performance. Nevertheless landings are the only available proxy for lobster abundance that has a time series greater than 20 years for LFAs in the Maritimes Region. Candidate reference points in the IFMP (Integrated Fisheries Management Plan) are based on landings. The period 1985-2004 was selected as the basis for trend-based reference points. The candidate upper and lower reference points are 80% and 40% of the median landings for this period.

Lobster landings data are available back to the 1890s. Landings are a function of abundance, level of fishing effort (trap hauls and soak days), timing of effort, fishing strategy and regulations, catchability (environmental, gear efficiency, density, and lobster movements), and the distribution of animals and effort. Variation in reporting levels also contributes to variation in landings. Thus, changes in landings are not a direct reflection of changes in abundance.

Major changes in effective effort during the 1980s and 90s were brought on by changes in vessels, traps and ship board electronics (i.e. sounders, radar, Loran, global positioning systems, mapping). Despite these major changes, the long time series available give indications of general trends and patterns in abundance.

Commercial lobster fishing began in the mid-1800s and annual lobster landings were first recorded in 1892. Canadian landings declined sharply during the 1890s and continued into the early 1920s. The landings remained low during the 1930s and early 1940s, rose following WW II and peaked in the mid-1950s, declining in the 1960s and 70s. Landings increased throughout the 1980s as part of a western Atlantic wide pattern that saw landings increase over the entire lobster's range.

Landings Since 1947

In LFA 27, landings rose to unprecedented levels during the 1980s and peaked in 1990 followed by a similarly sharp decline before levelling out in 1997 (Figure 2, Table 2). Landings have increased since 2000, with the mean of the last 3 years approximately 1.3 times the median landings for the period 1985-2004.

LFA 28-32 had a peak in the mid-1950s followed by an all time low in the late 1970s (Figure 2, Table 2). As with LFA 27, landings increased during the 1980s and peaked in 1990, though the increase was much smaller than observed in LFA 27. Landings rose sharply between 2004 and 2009. The mean of the last 3 years is approximately 5 times the median landings for the period 1985-2004, and almost matches the all time highs of 1895. Some differences within LFAs 28-32 are apparent (Table 2).

In LFA 33, landings reached all time lows in the late 1970s followed by an increase to a peak in 1987 (Figure 2, Table 2). Though landings declined in the early 1990s, they remained above levels observed since the 1920s and have increased since 2004. The mean of the last 3 years is approximately 1.5 times the median landings for the period 1985-2004.

The recent increases in landings are interpreted to reflect increased abundance, as there is no evidence of an increase in fishing effort prior to the increase. Since the increase in abundance, some fishermen have invested in new vessels and traps.

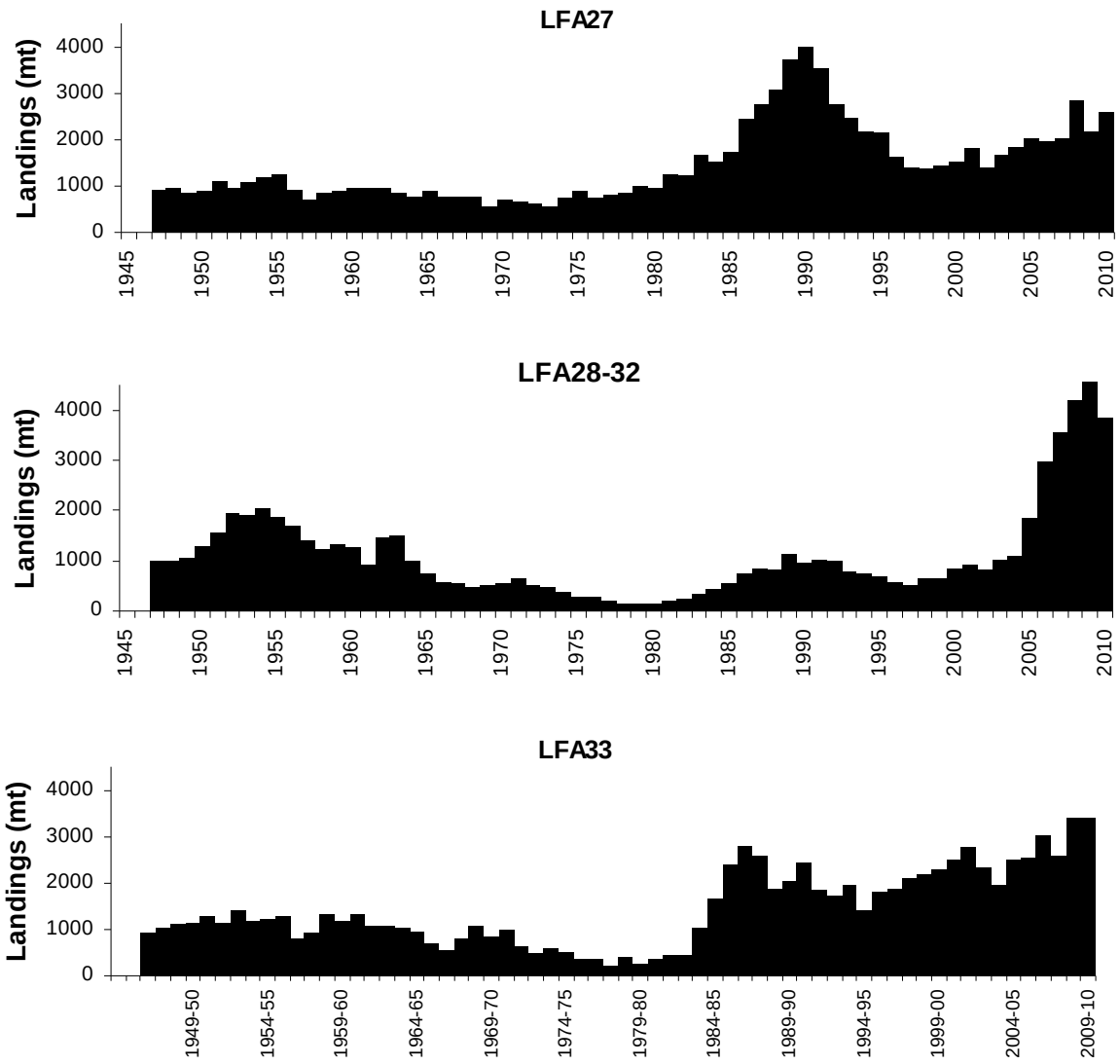


Figure 2. Lobster landings 1947-2010 by assessment units LFA 27; LFA 28-32 and LFA 33

Table 2. Lobster Landings 1980-2010 with 3 year mean (2008-2010) and the IFMP Candidate Upper Reference Point (IFMP Ref Pt; 80% of median 1985-2004)

Year	LFA 27	LFA 28-29	LFA 30	LFA 31	LFA 32	LFA 28-32	SEASON	LFA 33
1980	975	23	13	41	66	143	**1979-80**	248
1981	1267	45	35	70	56	206	**1980-81**	363
1982	1227	50	27	94	70	241	**1981-82**	448
1983	1658	63	62	120	109	354	**1982-83**	461
1984	1502	74	69	169	140	452	**1983-84**	1044
1985	1721	113	60	183	180	536	**1984-85**	1658
1986	2420	154	85	223	284	746	**1985-86**	2385
1987	2763	200	99	303	258	860	**1986-87**	2794
1988	3070	203	77	326	222	828	**1987-88**	2589
1989	3716	257	132	482	239	1110	**1988-89**	1888
1990	3970	172	119	365	303	959	**1989-90**	2037
1991	3526	168	151	401	298	1018	**1990-91**	2420
1992	2778	150	167	358	304	979	**1991-92**	1849
1993	2458	104	132	284	279	799	**1992-93**	1731
1994	2190	104	130	240	262	736	**1993-94**	1968
1995	2141	107	126	229	219	681	**1994-95**	1395
1996	1616	75	90	176	225	566	**1995-96**	1825
1997	1398	51	80	148	243	522	**1996-97**	1867
1998	1347	64	70	200	309	643	**1997-98**	2104
1999	1425	55	70	217	316	658	**1998-99**	2162
2000	1505	59	54	299	448	860	**1999-00**	2297
2001	1819	71	98	304	433	906	**2000-01**	2521
2002	1395	65	79	313	358	815	**2001-02**	2753
2003	1659	138	73	432	389	1032	**2002-03**	2320
2004	1850	198	84	518	289	1089	**2003-04**	1955
2005	2036	411	112	925	403	1852	**2004-05**	2519
2006	1966	668	187	1497	602	2954	**2005-06**	2556
2007	2024	800	216	1888	632	3535	**2006-07**	3033
2008	2849	1089	413	1993	704	4199	**2007-08**	2599
2009	2178	1099	452	2227	829	4607	**2008-09**	3402
2010	2568	926	371	1912	657	3866	**2009-10**	3377
Mean 2008-10	2532	1038	412	2044	730	4224		3126
Median 1985-2004	1996	110	88	301	287	822		2071
IFMP Ref. Point	1596	88	70	241	229	657		1656

Effort - 2002-2010

In LFA 27, effort as indicated by days fished (2002-2010) and total trap hauls (2004-2010) was stable or without trend. Estimated trap hauls from mandatory logs increased from 2004-2008 and then declined in the last two years. Different approaches used to estimate effort from the mandatory logs were in good agreement (Figure 3).

In the LFA 28-32 assessment unit, reported effort increased from 2005 to 2009 and decreased in 2010 (Figure 3). Within individual LFAs, the pattern varied. The total days fished and the mean days fished were either stable without trend (LFAs 28, 30, 32) or increased (LFAs 29, 31a, 31b). Estimated trap hauls from mandatory logs show a pattern similar to LFA 27 with increases in several LFAs up to 2008 followed by declines.

In LFA 33, reported effort increased by 10-15% from 2001-2002 to 2007-2008, with no apparent change in the last 3 fishing seasons (Figure 3). The changes occurred in total days fished, mean days fished and in estimated trap hauls from mandatory logs.

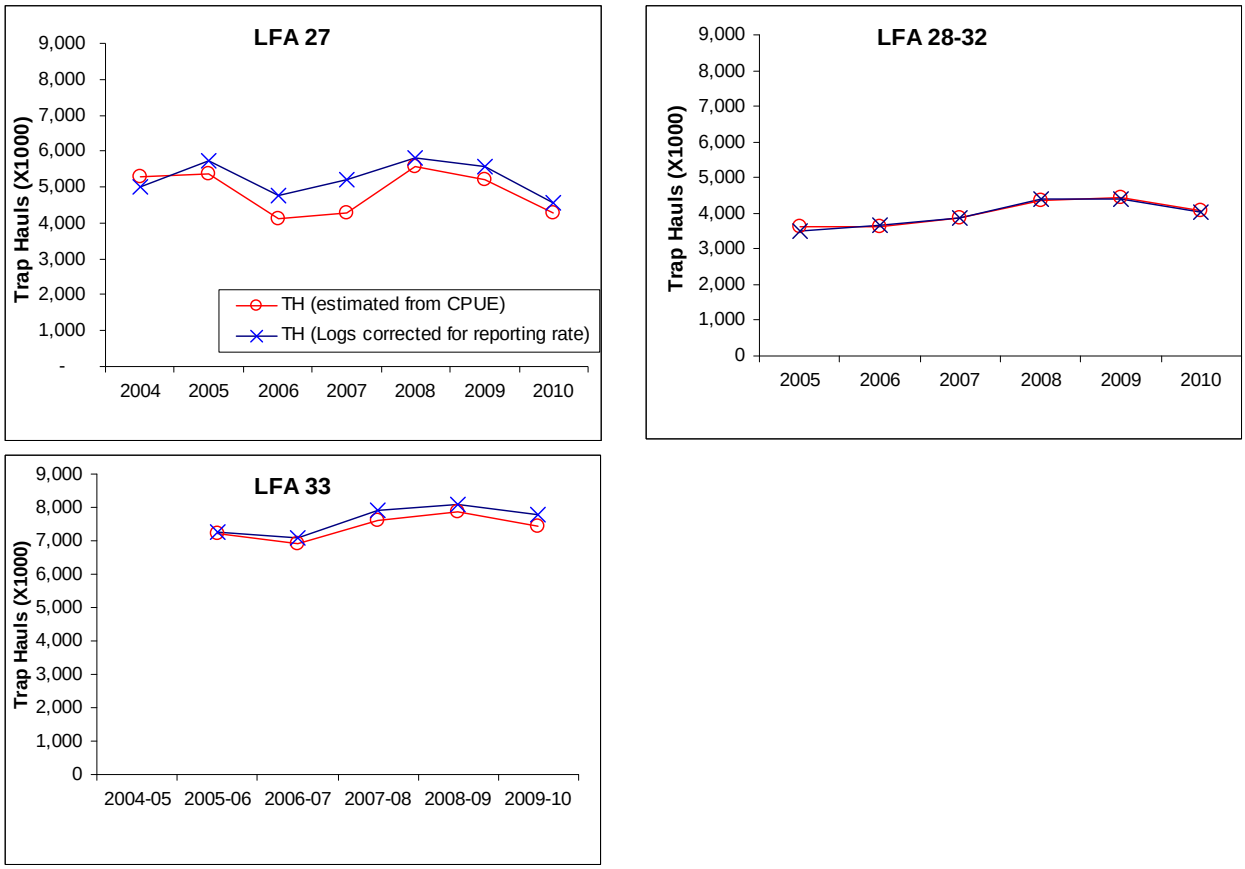


Figure 3. Total Trap Hauls (TH) from mandatory logs estimated in two ways: (i) total number from logs; corrected for reporting rate and (ii) total landings divided by CPUE from logs.

Commercial CPUE from Mandatory and Voluntary logs

Unstandardized commercial CPUE from mandatory logs differed among the assessment units and LFAs (Figure 4). CPUEs from voluntary logs come from fewer fishermen than the mandatory logs, but for some LFAs, the time series is 10-20 years longer than the mandatory logs. Unstandardized CPUE from mandatory logs corresponds well with unstandardized CPUE from voluntary logs where the two data types overlap (Figure 4). The correspondence between the CPUE trends in the two data sets indicates a longer time series of commercial CPUE could be built, and it would be useful to develop a standardized CPUE index from the mandatory log CPUE in the future.

The available data indicate some substantial increases in commercial CPUE (Figure 4). Unstandardized commercial CPUE from available logs in LFA 27 has trended upwards since

2002. Unstandardized commercial CPUE from available logs in LFAs 28-32 has trended upwards since the 1990s. This trend was strongest from 2004 to 2009. Unstandardized commercial CPUE from available logs in LFA 33 CPUE has trended upwards since the 1990s.

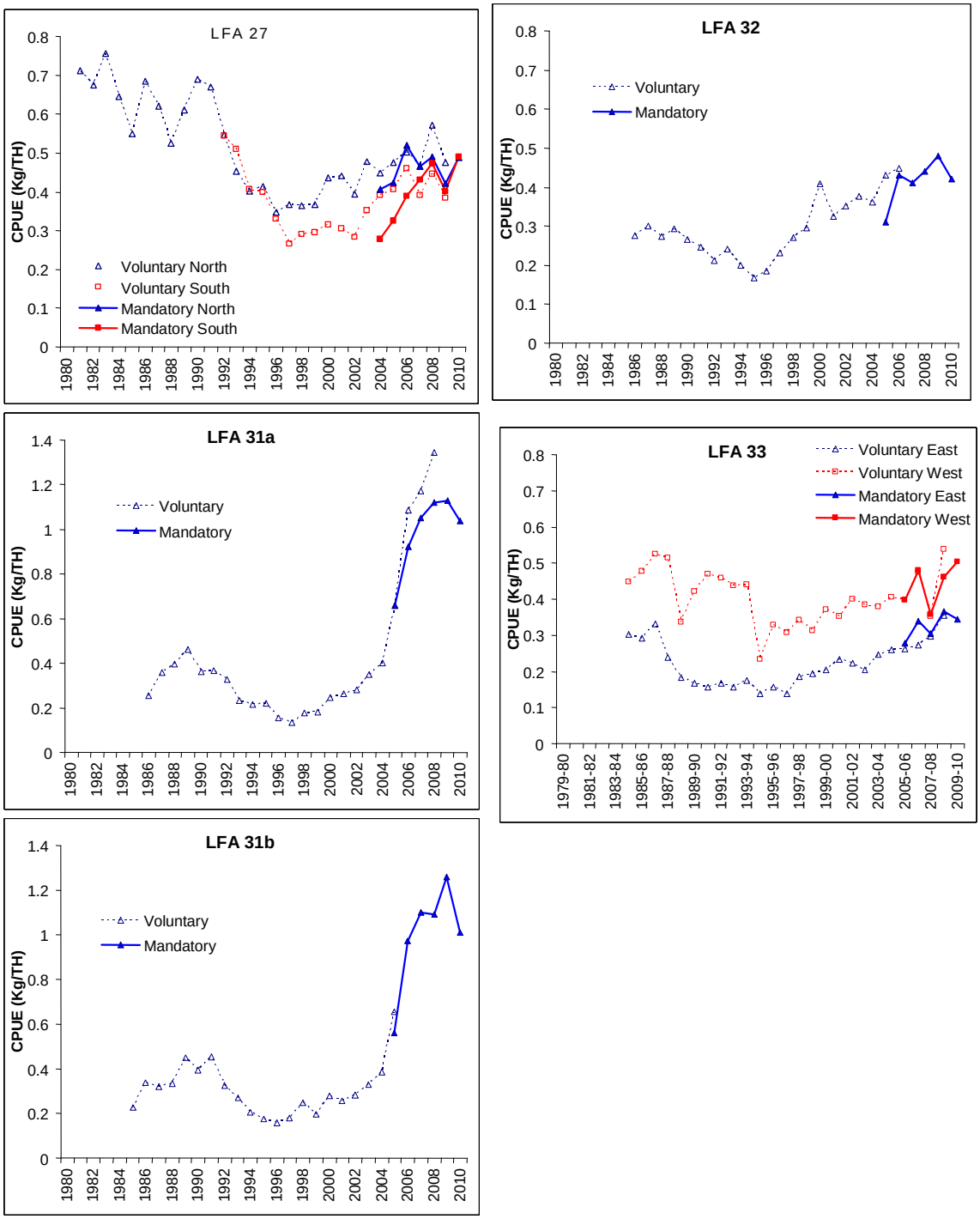


Figure 4. Mean (unstandardized) CPUE (kg/TH) from voluntary logs and mandatory logs for LFA 27 (north and south), LFA 31a, LFA 31b, LFA 32, and LFA 33 (east and west).

Median Sizes in Landed Catch

In LFA 27, the median sizes have increased since 1997 due to increases in the Minimum Legal Size (MLS).

The median sizes in LFA 29 decreased from 1999 to 2005 but increased from 2007 to 2009. LFAs 31A and 31B showed similar decreases until 2007 (at-sea sample data were not accessed for the most recent years). A decrease in the median size is consistent with increasing recruitment as larger numbers of lobsters are recruited to legal size. No trend was observed in LFA 32.

The median sizes in LFA 33 shows no long term trend in the fall, and a lack of recent data makes it impossible to determine median size for the spring period.

Stock Trends

The main abundance trends for all assessment units in recent years come from CPUE expressed in numbers per trap haul (N/TH) or weight per trap haul (kg/TH). Where CPUE has been standardized with a model it is referred to as an index or indices. Unstandardized CPUE refers to the mean of the annual CPUE from all available fishermen.

An index of exploitation rate (ER) was estimated using the Continuous Change in Ratio (CCIR) method, which utilizes the change over the course of the fishing season of the ratio between an unharvested size class (reference class) and a harvested size class in FSRS recruitment traps. The harvested size class was defined as MLS to 90 mm CL. Estimates were done for subunits and then weighted by length of rocky shore to provide an index for the assessment unit as a whole.

LFA 27

CPUE

CPUE indices for sublegals generally increased in three of four subunits from 1999 to 2010 (Figure 5), and the mean of the last 3 years for a weighted index for LFA 27 overall is above the median for 1999 to 2007 (Figure 6).

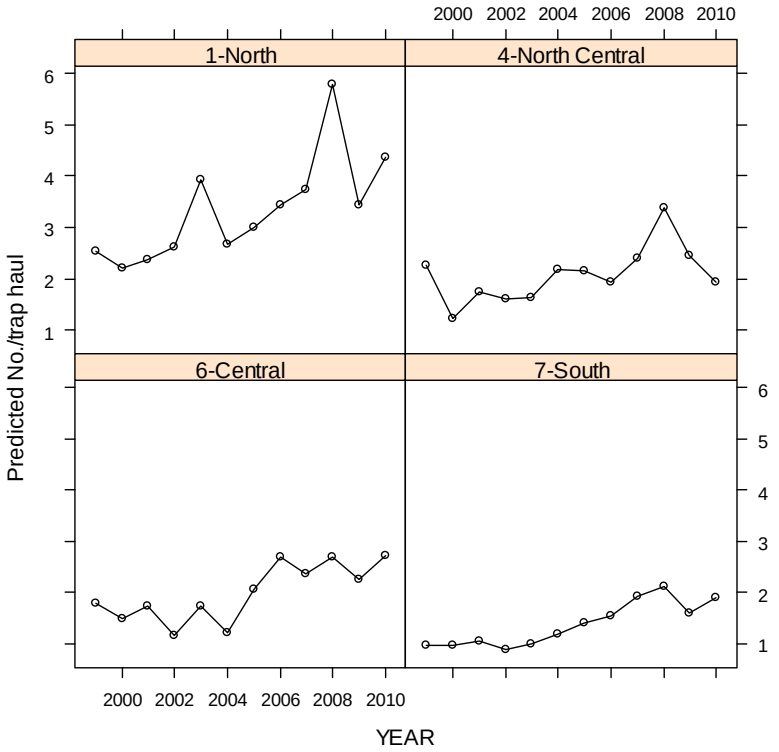


Figure 5. CPUE index of sublegal sizes for LFA 27 subunits from model of FSRS data.

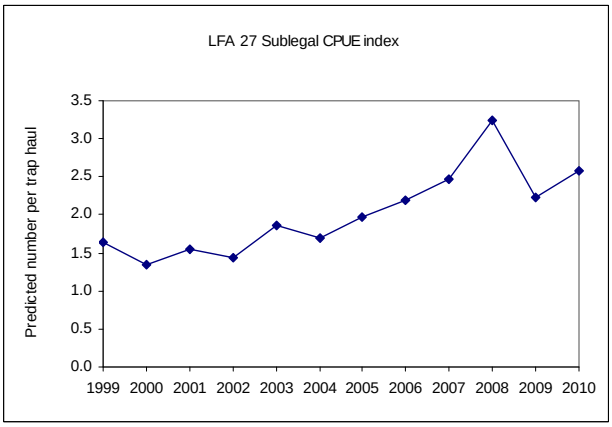


Figure 6. CPUE index of sublegal sizes for LFA 27 as a whole. From model output for each subunit weighted by length of rocky shoreline.

The increase in the CPUE index of sublegals is consistent with the increase in MLS (minimum legal size) in LFA 27 from 70-76 mm CL (1998-2002) and 76-81 mm CL (2007-2009).

A CPUE index for legal sizes fluctuated without trend (Figure 7) but the mean for 2008-2010 is above the median for 1999-2010. There were differences among subunits with the southern part trending upwards while LFA 27 north-central trended downwards in recent years. Although the CPUE index based on numbers has not increased, the median size in the landed catch in LFA 27 has increased. This explains the increase in the unstandardized CPUE from logs (Figure 4) which has units of weight per trap haul.

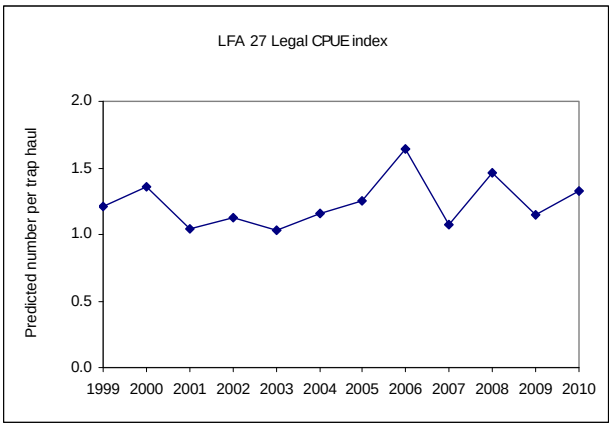


Figure 7. CPUE index of legals sizes for LFA 27 as a whole. From model output for each subunit weighted by length of rocky shoreline.

Unstandardized CPUE of ovigerous females in FSRS traps in LFA 27 is up substantially from 1999, as is the unstandardized CPUE of ovigerous females in voluntary fishing logs (Figure 8). Unstandardized CPUE of ovigerous females in at-sea samples in the port of Little River (LFA 27-north central) also increased since about 2003. The increase in the unstandardized CPUE of ovigerous female CPUE is consistent with expectations from an increase in minimum legal size.

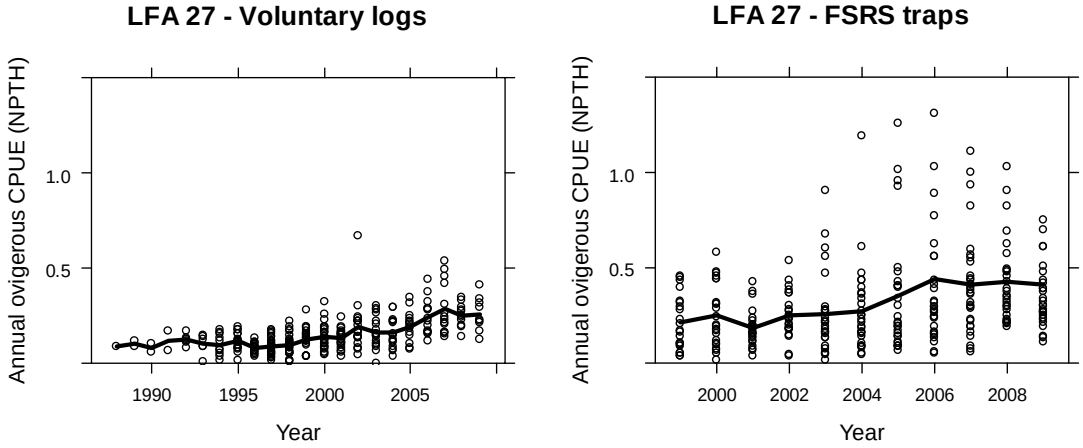


Figure 8. Unstandardized CPUE of berried females from (a) voluntary logs in LFA 27, 1987-2009 and (b) FSRS traps, 1999-2009. Each point is the annual CPUE for one fisherman; solid line is annual mean.

Exploitation Rate

An index of ER using CCIR was 0.77 (mean of 2008-2010), close to the median for the 1999-2007 period (0.76) (Figure 9).

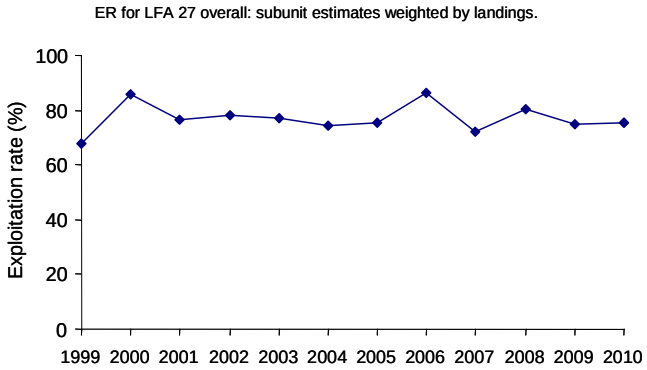


Figure 9. Exploitation rate index for LFA 27 as a whole based on weighting subunit estimates by landings.

An index of ER (extended ER) that accounts for the increases in MLS from 2007 to 2009, indicates that ER in LFA 27 was approximately 30% lower once the current MLS was reached. Given the above, it is concluded that current levels of exploitation do not threaten sustainability of lobsters in LFA 27 under current environmental conditions.

LFAs 28-32

CPUE

A CPUE index for sublegals increased substantially from 2002 to 2007 within most LFAs (Figure 10) and overall (Figure 11). The increase was centred in LFAs 29, 31 and 30 and was not as pronounced in LFA 32. The overall index declined recently but the mean of the last 3 years is still above the median for 2000-2007.

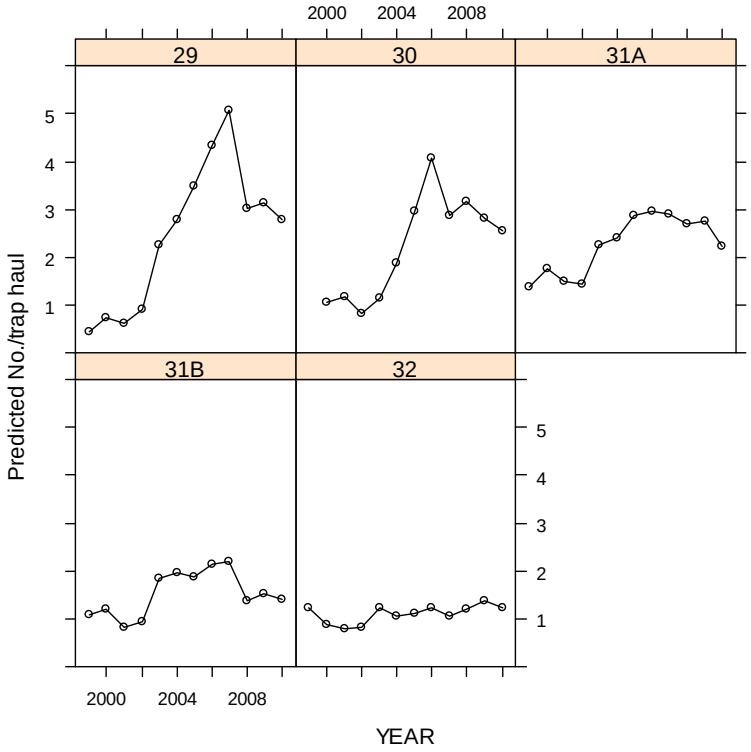


Figure 10. CPUE index of sublegal sizes for LFAs 29-32 from a model of Fishermen and Scientists Research Society (FSRS) data.

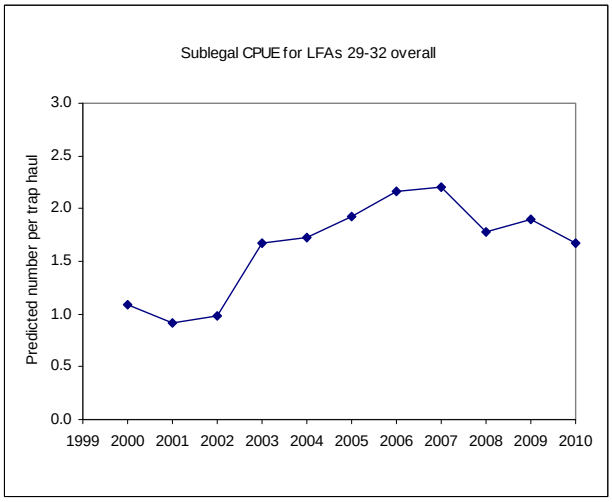


Figure 11. CPUE index of sublegal sizes for LFAs 29-32 as a unit. From model output for each subunit (LFA) weighted by length of rocky shoreline.

A CPUE index for legal sizes in LFAs 29-32 as a unit (Figure 12) followed the sublegal index trend, increasing from 2004 to 2009, with the mean of the last 3 years 1.7 times the median for 2000-2007. Given the decline in the sublegal index, CPUE of legal sizes will likely decline in the coming years but the extent of decline is uncertain.

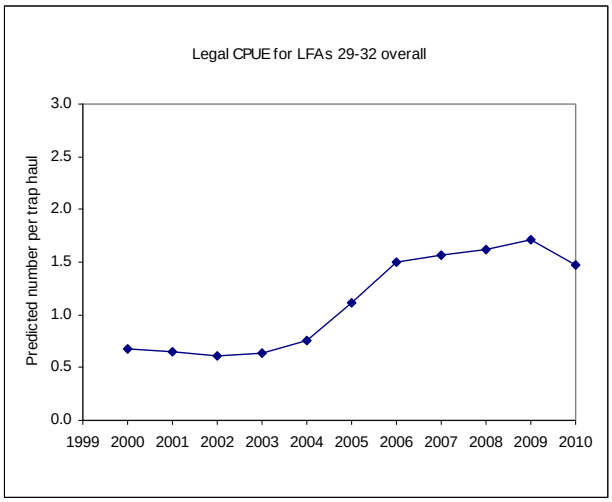


Figure 12. CPUE index of legal sizes for LFAs 29-32 as a whole. From model output for each subunit (LFA) weighted by length of rocky shoreline.

Unstandardized CPUE from available fishermen logs increased, particularly since 2004. Unstandardized CPUE of legal sizes from available voluntary logs in LFA 31 increased by 65-70% from 2004 to 2005, and unstandardized CPUE from mandatory logs increased by 70-120% (Figure 4).

An egg index for LFA 31A was developed by expanding the size composition from at-sea samples to the fishery from an abundance index and using the length-fecundity relationship to estimate the total number of eggs. This approach currently uses landings for the abundance index but other abundance indices could be employed. The egg index was substantially higher in more recent years compared to 2002-2003, similar to the landings (Figure 13).

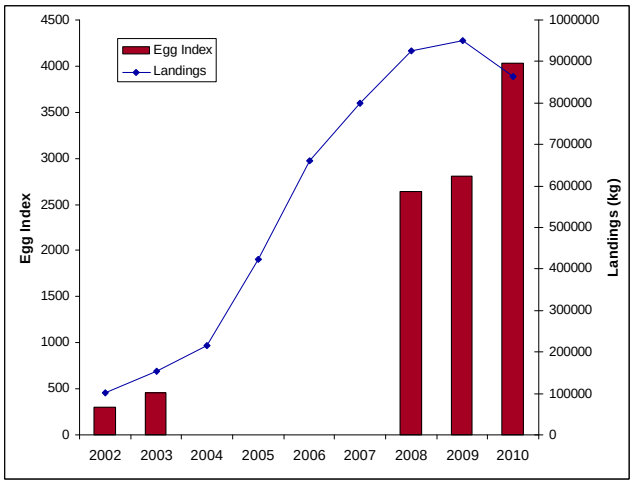


Figure 13. Egg index and landings for LFA 31A 2002, 2003, 2008, 2009, 2010.

Exploitation

An index of ER using CCIR fluctuated with no consistent trend over the 2000-2010 period (Figure 14). Mean ER for the last 3 years (0.61) is below the median for 2000-2007 (0.70). Within individual LFAs, the ER index has decreased or remained stable. Given that abundance increased substantially over this period while effort remained stable or increased, it is concluded

that current levels of exploitation do not threaten sustainability of lobsters in LFAs 29-32 under current environmental conditions.

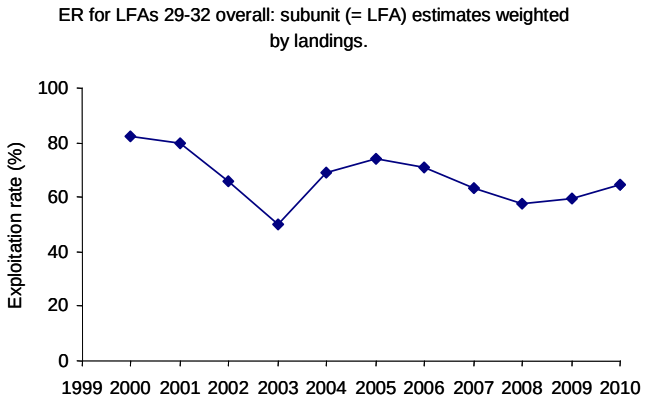


Figure 14. ER index for LFAs 29-32 as a whole based on weighting LFA estimates by landings.

LFA 33

CPUE

A temperature-corrected abundance index for sublegals (76-80 mm CL) increased from 1999-2000 to 2008-2009 and the mean for the two seasons ending in spring 2009 was 1.3 times the median of the period 1999-2000 to 2006-2007.

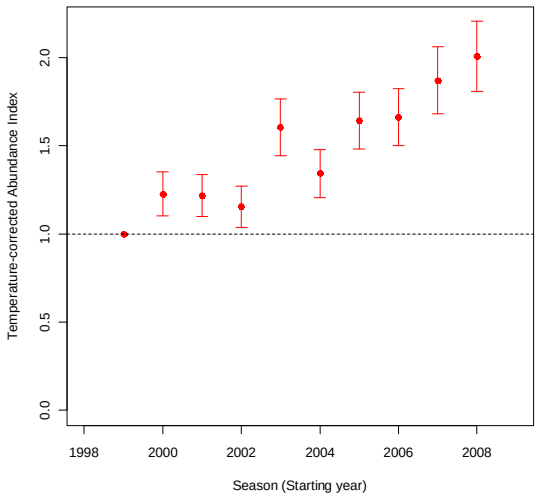


Figure 15. Temperature-corrected abundance index and 95% confidence interval for sublegal lobsters (76-80 mm CL) in LFA 33. Estimates are relative to the first available fishing season (1999-2000 = 1).

Unstandardized CPUE for sublegals in LFA 33 also increased from 2001-2002 to the 2009-2010 season (Figure 16).

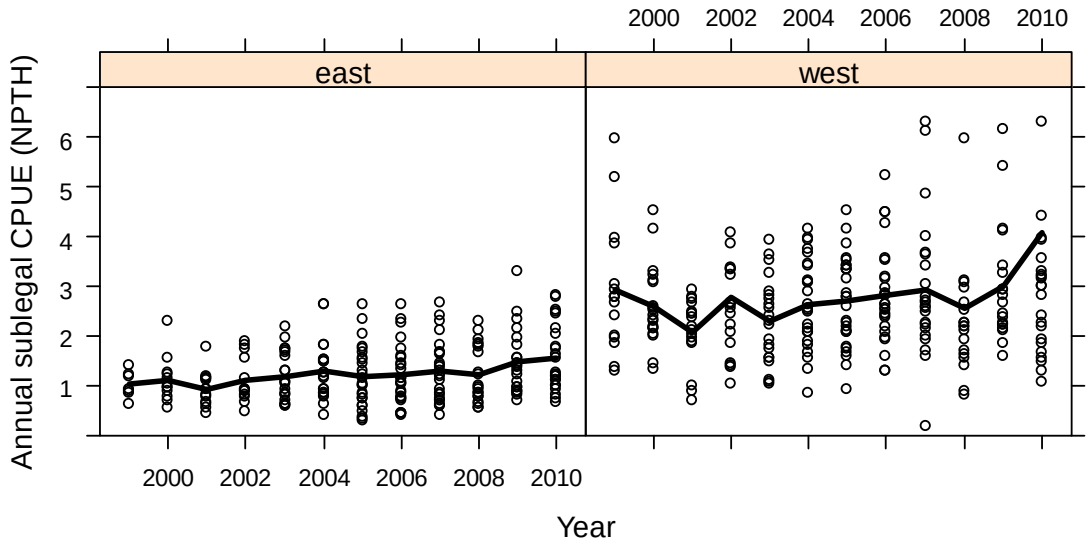


Figure 16. Unstandardized CPUE for sublegals in FSRS traps for LFA 33 east and west. Each point is the annual CPUE for one fisherman; solid line is annual mean. Three points between 10 and 16 in 2010 (west) are not shown.

Unstandardized CPUE of legal sizes in FSRS traps fluctuated without trend. In the available voluntary logs and in the more recent data from mandatory logs, unstandardized CPUE of legal sizes increased over the last 10 years (Figure 4). Given that the spatial distribution of the FSRS traps in LFA 33 was less well-matched to the distribution of the commercial traps than in the other assessment units, the data from fishing logs are thought to be a better indicator of commercial CPUE than the FSRS traps.

Exploitation

An index of exploitation based on CCIR fluctuated with a slight downward trend (Figure 17). Mean ER for the last 3 years ending in spring 2010 (0.67), is below the median for 1999-2000 to 2006-2007 (0.76).

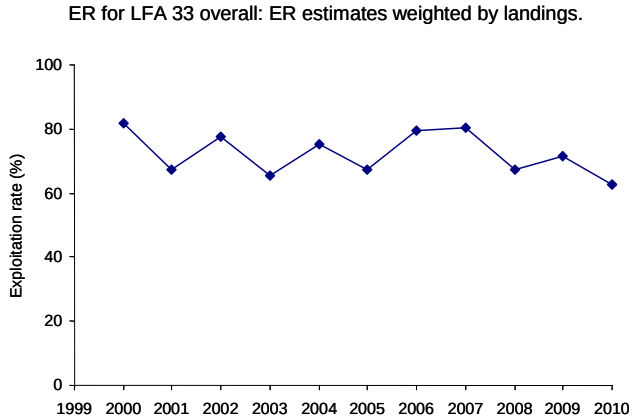


Figure 17. Exploitation rate index for LFA 33 as a whole based on weighting subunit (east and west) estimates by landings.

Given the trends within LFA 33 of increasing abundance and a small increase in effort in recent years, it is concluded that current levels of exploitation do not threaten sustainability of lobsters in LFA 33 under current environmental conditions.

Size at Onset of Maturity in LFAs 27, 31a, 32, 33 and 34

Size at onset of maturity (SOM) for female lobsters was estimated for 3 locations in Cape Breton from 2006-2008. SOM estimates varied annually, spatially and seasonally. Best estimates for SOM50 (size at which 50% of lobsters have reached SOM) for the time period were 71.5-72.4 mm CL for Dingwall (LFA 27), 75.6-75.8 mm CL for False Bay (LFA 27) and 74.7-75.8 mm CL for Petit de Grat (LFA 29). The percent mature at the minimum legal size (MLS) based on logistic models ranged from 77-100%.

SOM estimates are not yet available but are being studied in LFAs 31 to 34. The assessment of sexual maturity of female lobsters was evaluated from observed development of cement glands (CG) and the presence of egg carrying females (ovigerous). The study was initiated in 2008 in the area of Canso (LFA 31A). In 2009, this study expanded geographically to Port Mouton (LFA 33). In 2010, sampling was initiated in Tangier (LFA 32) and Lobster Bay (LFA 34). These sites were again sampled in 2011. A total of 11,744 female lobsters have been sampled (all areas) and data analyses are in progress. Of all sublegal lobsters sampled at each location in 2011, the percentage that were mature was highest off Canso (67-91%) followed by Tangier (5-19%), Port Mouton (up to 5%) and Lobster Bay (Inside area: up to 4%; Outside area: up to 2%). The mean size of sublegals in the areas sampled was 78 mm (Canso), 74 mm (Tangier), 75 mm (Port Mouton) and 77-78 mm in Lobster Bay. In addition the smallest ovigerous females were in the east. In 2011 ovigerous females as small as 66 mm CL were found off Canso . Off Tangier the smallest was 69 mm; off Port Mouton it was 77 mm and In Lobster Bay it was 82 mm. Although SOM estimates are not available for sites in LFAs 31A, 32 and 33, evidence suggests a spatial trend of increasing SOM going from LFA 31A to LFA 33.

Sources of Uncertainty

Sources of uncertainty related to landings are found in the section on Fishery Performance.

The main abundance trends for recent years for all assessment units come from CPUE during the fishery. There are no fishery independent data on abundance for LFAs 27-33. CPUE in FSRS traps are of value because they come from standard traps which are consistent from year to year, but even these are fished during the fishing season so are not truly fishery independent.

Catch rates (CPUE) are a function of abundance and catchability. Catchability is affected by environmental conditions, gear efficiency including trap design and bait, and other factors. Changes in any of these can affect catch rates. While one CPUE index presented does account for temperature, the bulk of the available CPUE time series do not account for any of the factors mentioned above.

Any changes in fishing efficiency (or “effective effort”) have not been accounted for here. If fishing efficiency has increased over time due to larger vessels, better navigation or improved fishing strategy, then CPUEs (mean and modelled) will inflate our perception of abundance in recent years. The CPUE indices based on FSRS traps usually trended in a manner similar to CPUE from voluntary logs, indicating that any changes in fishing efficiency in the last 10 years are not affecting our perception of abundance.

CPUE calculations from mandatory logs depend on accurate data. While the editing process removes some data that are obviously misreported, some inaccuracies may remain. The favourable comparisons between the mandatory log CPUE and the voluntary log CPUE (which is likely to be accurate) indicate that any remaining data errors are not influential on the interpretation of CPUE trends.

The effect of movement of licenses within LFAs on CPUE measures has not been accounted for.

The CPUE for legal and ovigerous females based in FSRS recruitment traps may be different than those in commercial traps due to different design and distribution of traps. This is likely to be an issue mainly in LFA 33 where more fishing takes place further from shore. Although the CPUE may be different, it is assumed the CPUE trends in the FSRS traps are indicative of abundance trends.

CONCLUSIONS

LFA 27

Landings in 2010 in LFA 27 (2,568 t), and the mean for the last 3 years (2,532 t) were above the median for 1985 to 2004 (1,996 t). Indicators of stock health for lobsters in LFA 27 overall are positive. The increase in MLS has resulted in an increase in sublegals, ovigerous females, the median size of the landed catch, and commercial catch rates. The increased MLS means that a size class that was exploited is now unexploited, effectively decreasing exploitation of the stock. An ER index for LFA 27 indicates the rate of removals from the exploitable population has been stable without trend, and it is concluded that the current levels of exploitation do not threaten sustainability under current environmental conditions.

LFAs 28-32

Landings in 2010 in LFA 28-32 (3,866 t) and the mean for the last 3 years (4,224 t) were well above the median for 1985 to 2004 (822 t). Indicators of stock health for lobsters in LFAs 28-32 overall are mainly positive. A CPUE index for sublegals increased substantially from 2002 to 2007. A CPUE index for legal sizes in LFAs 29-32 as a unit followed the sublegal index trend, increasing from 2004 to 2009, with the mean of the last 3 years 1.7 times the median for 2000-2007. These CPUE indices have decreased in recent years, but both remain at high levels. LFAs 32 and 28 did not experience the large increases in abundance seen in LFAs 29, 30 and 31. An index of egg production for LFA 31A is currently high. An ER index for LFAs 28-32 has been stable without trend. Within individual LFAs, the ER index has decreased or remained stable, and it is concluded that the current levels of exploitation do not threaten sustainability under current environmental conditions.

LFA 33

Landings in 2009-2010 in LFA 33 (3,377 t) and the mean for the last 3 years (3,126 t) were above the median for 1984-1985 to 2003-2004 (2,071 t). Indicators of stock health for lobsters in LFA 33 overall are positive. A temperature-corrected abundance index for sublegals (76-80 mm CL) increased from 1999-2000 to 2008-2009 and the mean for the two seasons ending in spring 2009 was 1.3 times the median of the period 1999-2000 to 2006-2007. Unstandardized CPUE of legal sizes in FSRS traps fluctuated without trend but unstandardized CPUE of legal sizes in voluntary and mandatory logs indicate an increase since the late 1990s.

An ER index for LFA 33 fluctuated with a slight downward trend and it is concluded that the current levels of exploitation do not threaten sustainability under current environmental conditions.

OTHER CONSIDERATIONS

Yield Per Recruit

Although current exploitation rates are unlikely to threaten sustainability of lobsters in any of the assessment units through "recruit overfishing", lower exploitation rates may still increase yield per recruit. Previous studies of lobsters in this region have indicated reducing effort or increasing minimum legal size would increase yield per recruit and eggs per recruit.

A yield per recruit analysis was outside the scope of this assessment and would have to account for the substantial increase in minimum legal size in LFA 27, management changes elsewhere and updated values for size at maturity. Potential density dependent effects on growth and maturity would also need consideration. Economic considerations could also be built into the analysis.

Bycatch and Discards

The unintended capture of species that are not the target of a fishery is referred to as bycatch. Retained bycatch are either sold or used as bait, while discarded bycatch can be a source of mortality. Depending upon the LFA, fishermen can legally retain rock crab, Jonah crab, green crab and sculpins. In the lobster fishery, lobsters under the legal size, or those with eggs (berried) must be discarded. Depending upon the LFA, lobsters over a maximum size (LFA 30), in a window size (LFA 31a), or V-notched must also be discarded. While mortality amongst these discards is considered to be low, the amount of the discards has not been evaluated in the past.

Preliminary results from the 2009 to 2010 *SARA* (*Species at Risk Act*) bycatch study give the first systematic data on bycatch and discards in LFAs 27-34, giving an overview of the species caught, the estimated bycatch and discard rate (kg/ton lobster landed), and total in the fishery (kg).

The species present and catch rates vary greatly among LFAs. The non-lobster portion of the total catch varies from 1.5% in LFA 31B to 13% in LFA 33. If those species that can legally be kept for bait or sale are not included, then the discarded bycatch ranges from 0.1% (LFA 32) to 7.5% (LFA 33) of the total catch. There were low occurrences of the *SARA*-listed species.

Overall lobster discard rates were highest in LFA 27 with an estimated discard rate of 1.27 kg of lobsters discarded for each kg of lobster landed, followed by LFA 32 (0.79 kg), LFA 34 (0.74 kg), LFA 33 (0.47 kg) and LFA 30-31B (0.22-0.25 kg).

Sublegal sized lobsters represent the majority of discards. In LFA 27, 33 and 34 they exceed 90% of the discards while in LFA 30-31B range between 72-79%. In LFA 32 the sublegals represent 53% of the discards.

Both positive and negative reports on the quality of observer performance were provided at the meeting. In light of these, the quality of the data needs to be further investigated. There are

other data sources that could be compared with some of these data (i.e. lobster at-sea sampling data, FSRS-DFO ecosystem sampling, cusk sampling in LFA 34).

The final report on this project should include more details on the seasonality, spatial extent and methods to better evaluate the uncertainty in estimation, especially in LFAs where sampling size is small. Trap design and bait were not recorded, cannot be assessed, and should be recorded if this study is repeated.

The consequence of the various methods for extrapolating from the samples to total amounts should also be further evaluated and additional methods for quantifying and reporting uncertainty investigated.

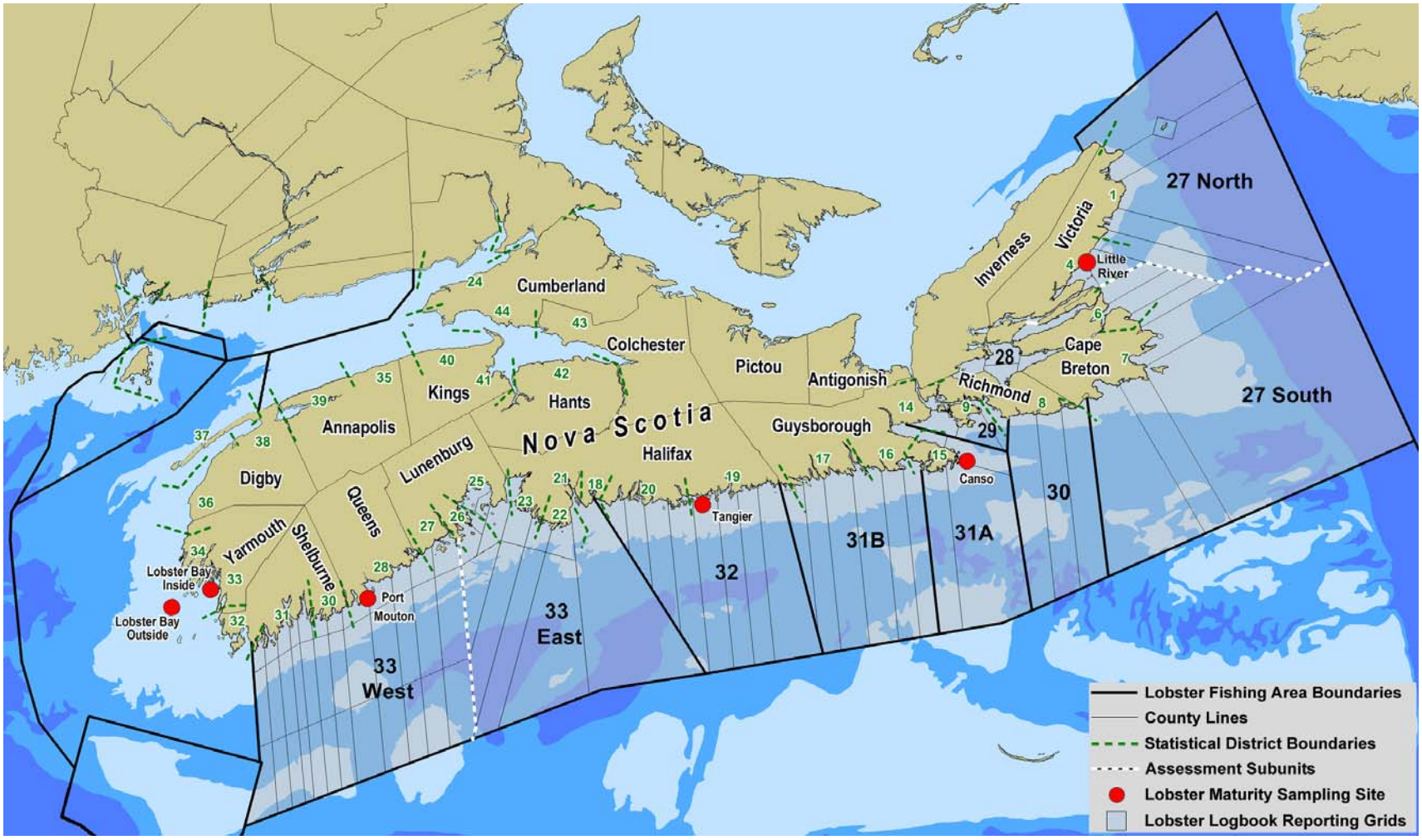
SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, Regional Advisory meeting of July 21-22, 2011, on the assessment of lobster off the Atlantic coast of Nova Scotia. A meeting to develop the framework for this assessment was held February 1-3, 2011. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

Tremblay, J., D. Pezzack, C. Denton, A. Reeves, S. Smith, A. Silva, and J. Allard. 2011. Framework for Assessing Lobster off the Coast of Eastern Cape Breton and the Eastern and South Shores of Nova Scotia (LFAs 27-33). DFO Can. Sci. Advis. Sec. Res. Doc. 2011/058: viii + 180 p.

APPENDIX 1.

Map showing assessment units (LFA 27, LFAs 28-32, LFA 33), assessment subunits (for LFAs 28-32 LFAs are assessment subunits), and locations mentioned in text.



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