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Assessment of lobster off the coast of eastern Cape Breton and the eastern and south shores of Nova Scotia (LFAs 27-33)

Évaluation des homards au large des côtes à l'est du cap Breton et dans les régions côtières à l'est et au sud de la Nouvelle-Écosse (ZPH 27 à 33)

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ABSTRACT

Lobster Fishing Areas (LFAs) 27-33 are located on the Atlantic coast of Nova Scotia, stretching from the northern tip of Cape Breton Island in the north to Barrington Bay (Shelburne County) in the south. An assessment of the status of these LFAs was conducted in 2011. The assessment is for the seasons ending in spring 2010. Indicators of stock health come primarily from the catch rate (CPUE) in commercial traps, or in Fishermen and Scientists Research Society (FSRS) traps. Other data inputs include commercial landings and lobster sizes. Analysis of the sizes of lobsters in FSRS traps versus those captured in commercial traps indicates they are comparable, with the exception of LFA 33 during the fall season. In LFA 27, indicators of stock health 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 to 2004 (1,996 t). CPUE abundance indicators for sublegals, legal sizes and ovigerous (“berried”) females are positive. The increase in the abundance indicators for 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). In LFAs 28-32, indicators of stock health for lobsters 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 to 2004 (822 t). CPUE abundance indicators for sublegal and legal sizes indicate substantial increases. A CPUE index for sublegals increased from 2002 to 2007 and declined recently, but the mean of the last 3 years is still above the median for 2000 to 2007. An egg index for LFA 31a was substantially higher in more recent years (2008 to 2010) compared to 2002 to 2003. In LFA 33, indicators of stock health are positive. Landings in LFA 33 for the 2009-10 season (3,377 t) and the mean for the last 3 years (3,126 t) were above the median for 1984-85 to 2003-04 (2,071 t). CPUE abundance indicators are positive or neutral. Unstandardized commercial CPUE from available logs in LFA 33 CPUE has trended upwards since the 1990s. A temperature-corrected abundance index for sublegals (76-80 mm CL) increased from 1999-00 to 2008-09. Unstandardized CPUE of sublegals in FSRS traps increased from the 2000-01 season, while unstandardized CPUE of legal sizes fluctuated without trend.

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.

RÉSUMÉ

Les zones de pêche au homard (ZPH) 27 à 33 sont situées sur la Côte atlantique de la Nouvelle-Écosse, de l'extrémité nord de l'île du cap Breton à la baie Barrington (comté de Shelburne) au sud. L'évaluation de l'état de ces ZPH a été menée en 2011. L'évaluation est menée dans le cadre des saisons qui se terminent au printemps 2010. Les indicateurs de la santé du stock proviennent principalement du taux de prise (PUE) des casiers commerciaux ou des casiers de la Fishermen and Scientists Research Society (FSRS). Parmi d'autres saisies de données se trouvent les débarquements commerciaux et la taille du homard. Les analyses de la taille des homards des casiers de la FSRS par rapport à celle des casiers commerciaux indiquent une comparaison, à l'exception de la taille des homards de la ZPH 33 au cours de l'automne. Dans la ZPH 27, les indicateurs de la santé du stock sont positifs. Les débarquements en 2010 dans la ZPH 27 (2 568 t) et la moyenne au cours des trois dernières années (2 532 t) se situent au-dessus du taux médian de 1985 à 2004 (1 996 t). Les indicateurs d'abondance des PUE des femelles de taille inférieure à la taille réglementaire, de taille légale ou ovigères (femme œuvée) sont positifs. L'augmentation des indicateurs d'abondance des femelles ovigères et des femelles de taille inférieure à la taille réglementaire correspond aux attentes liées à l'augmentation de la taille réglementaire minimale dans la ZPH 27 de la longueur de carapace (LC) de 70 à 76 mm (1998-2002) et de 76 à 81 mm (2007-2009). Dans les ZPH 28 à 32, les indicateurs de la santé du stock de homard sont principalement positifs. Les débarquements en 2010 dans les ZPH 28 à 32 (3 866 t) et la moyenne au cours des trois dernières années (4 224 t) se situent au-dessus du taux médian de 1985 à 2004 (822 t). Les indicateurs d'abondance des PUE des tailles inférieures à la taille réglementaire et des tailles légales démontrent des augmentations considérables. L'indice des PUE pour les tailles inférieures à la taille réglementaire a augmenté de 2002 à 2007 et a diminué récemment, mais la moyenne au cours des trois dernières années se situe toujours au-dessus de la moyenne des années 2000 à 2007. L'indice des œufs pour la ZPH 31a était considérablement plus élevé au cours des récentes années (2008 à 2010), comparé à celui des années 2002 à 2003. Dans la ZPH 33, les indicateurs de la santé du stock sont positifs. Les débarquements de la saison 2009-2010 dans la ZPH 33 (3 377 t) et la moyenne au cours des trois dernières années (3 126 t) se situaient au-dessus du taux médian de 1984-1985 à 2003-2004 (2 071 t). Les indicateurs d'abondance des PUE sont positifs ou neutres. La PUE de la pêche commerciale non normalisée des journaux accessibles des PUE de la ZPH 33 est à la hausse depuis les années 1990. L'indice de l'abondance de la bonne température des tailles inférieures à la taille réglementaire (longueur de carapace de 76 à 80 mm) a augmenté de l'année 1999-2000 à l'année 2008-2009. Les PUE non normalisées des tailles inférieures à la taille réglementaire dans les casiers de la FSRS ont augmenté au cours de la saison de pêche de 2000-2001, alors que les PUE non normalisées des tailles légales ont fluctué sans afficher de tendance.

L'indice du taux d'exploitation a été stable ou a diminué légèrement pour toutes les unités d'évaluation. La conclusion révèle que les niveaux d'exploitation actuels ne menacent pas la durabilité des unités d'évaluation, dans le cas des conditions environnementales actuelles.

1. INTRODUCTION

1.1. CONTEXT AND TERMS OF REFERENCE FOR ASSESSMENT

The status of the lobster resources in Lobster Fishing Areas (LFAs) 27-33 was last assessed in 2004. The Department of Fisheries and Oceans' (DFO) Fisheries Management Branch 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 (DFO 2011; Tremblay et al. 2011).

The framework addressed the following objectives:

- Identify groups of LFAs for stock assessment.
- Identify links between life-history (size-at-maturity, recruitment) and lobster management (update and reporting on information and assumptions used).
- Identify strengths and weaknesses of fishery data inputs for providing indicators of abundance, size structure, recruitment, effort, spatial distribution of catch:
    - Port and at-sea sampling protocols.
    - Observer sampling, including bycatch sampling associated with the *Species at Risk Act* (*SARA*).
    - Logbooks.
    - Fishermen and Scientists Research Society (FSRS) information.
- Select indicators of abundance, with a focus on a proposed catch rate model.
- Select indicators of recruitment and reproduction (spawners).
- Select indicators of fishing pressure.
- For the selected indicators develop candidate reference points that would form the basis for decisions by Fisheries Management.
- Development of an assessment schedule, including guidelines for the monitoring of the indicators and other events that would trigger an earlier than scheduled assessment.

The current assessment builds on the framework and has the following objectives:

- Assess the stock status of the LFA 27-33 lobster stocks as of the end of the 2010 seasons.
- Estimate the relative exploitation rates over the last 10 years and evaluate the consequences of maintaining the current harvest levels.
- Estimate the level of discards (including lobster) and retention of non-lobster species in the LFA 27-33 lobster fisheries and report on what information is available on the survival of discarded species.
- Estimate the current values for female size at 50% maturity.

This Research Document addresses the first two objectives; additional research documents address the other objectives.

1.2. DOCUMENT ORGANIZATION AND SOME TERMINOLOGY

The document is structured to address some of the issues raised during the framework, and then to present and evaluate the different indicators for each of the three assessment units. The framework document provides an extensive review of lobster biology and the fisheries, describes and tabulates data inputs, and provides the approaches and some examples of how indicators were developed.

The following assessment units and subunits (parts of assessment units) are referred to (where appropriate data on subunits is provided):

Assessment Unit	Subunits (SD = Statistical district)
Northeastern Cape Breton (LFA 27)	SD 1, 4, 6, 7; North (SD 1 & 4); South (SD 6 & 7)
Southeastern Cape Breton, Chedabucto Bay and the eastern shore (LFAs 29-32)	LFAs 30, 28, 29, 31a, 31b, 32
South Shore (LFA 33).	East , West

1.3. INDICATOR SUMMARY TABLES

At the framework meeting in February 2011, a table of indicators was developed (Appendix 1). In the current document, tables are provided that summarize the conclusions about those indicators at the end of relevant sections.

2. FOLLOW-UP TO SOME POINTS RAISED DURING THE FRAMEWORK

At the framework meeting in February, for each of the Objectives, there were research recommendations and suggestions to clarify the robustness of the analysis (DFO 2011). Many of these were for future work, but here we address what was possible with the available time and resources.

2.1. CLUSTER ANALYSIS

At the framework, it was suggested that the robustness of the groupings be evaluated by splitting the time series. This was done and the results were included in the framework research document (Tremblay et al. 2011). The clusters resulting from the analysis of the 1985-2009 period were very similar to the clusters resulting from the analysis of the 1947-2009. This was not the case for the clusters based on the 1947-1984 period, suggesting that the landings trends in the last 25 years had relatively more weight in the analysis than the earlier years, likely due to the substantial increases in landings that occurred in many areas in the last 25 years. As the last 25 years is most relevant to the current situation, the reanalysis supports the three assessment units defined in the framework (LFA 27, LFAs 28-32 and LFA 33).

2.2. DEGREE TO WHICH FSRS TRAPS REPRESENT WHAT IS OBSERVED DURING COMMERCIAL FISHING

At the framework, there were questions raised regarding the degree to which the FSRS recruitment trap data represented the legal portion of the population. To evaluate this, we undertook two analyses: (i) spatial overlap between FSRS traps and commercial traps and (ii) size comparison between FSRS trap data and other data sources.

2.2.1. Spatial Overlap between FSRS and Commercial Traps

Data on commercial fishing locations comes from mandatory logs as well as locations from at-sea samples of commercial fishing. The locations from commercial logs are not at a fine enough scale for comparison with the FSRS logs. Locations recorded during at-sea samples from the 1970s to the present were used to represent the location of commercial fishing. A map of these locations versus FSRS trap locations indicate that for LFAs 27-32, FSRS trap locations are not restricted to the inner most fishing locations and fishing occurs both landward and seaward of the FSRS trap locations (Fig. 2.1a and b). In LFA 33 and in the Gulf of Maine, there is an increasingly higher proportion of commercial fishing that occurs outside of the FSRS trap locations, so for these areas we expect that the FSRS traps will be less representative of what is captured by commercial traps. Of course, even in LFAs 27-32, the FSRS trap locations are greatly outnumbered by the commercial fishing locations, so in this sense they may at times not represent what is captured by commercial traps. In addition, the FSRS traps are generally lower volume and have smaller entrance rings.

The locations of FSRS commercial traps in LFA 33 were much more extensive than those of the recruitment traps (Fig. 2.2). Unfortunately, challenges with the data format prevented further exploration of this data in the current assessment.

2.2.2. Size Comparison between FSRS Trap Data and Other Data Sources

Methods

Size data from the FSRS traps and at-sea samples were compared for LFAs 27, 31a and LFA 33 (East and West). The at-sea sampling of 1 mm size groups were combined to correspond with the FSRS size groups as listed below:

FSRS Size Groupings (as of fall 2003)

Size 1 (less than 11mm)
Size 2 (11mm – 20.9mm)
Size 3 (21mm – 30.9mm)
Size 4 (31mm – 40.9mm)
Size 5 (41mm – 50.9mm)
Size 6 (51mm – 60.9mm)
Size 7 (61mm – 70.9mm)
Size 8 (71mm – 75.9mm)
Size 9 (76mm – 80.9mm)
Size 10 (81mm – 90.9mm)
Size 11 (91mm – 100.9mm)
Size 12 (101mm – 110.9mm)
Size 13 (111mm – 120.9mm)
Size 14 (121mm – 130.9mm)
Size 15 (greater than 131mm)

The size frequencies were plotted together with the two Y-axes scaled to a common level based on the numbers in the size group corresponding to legal size.

The FSRS data is a composite of the catch in two to five standard traps fished by a number of fishermen, from each day of fishing during the season. The FSRS traps are in fixed positions and thus, represent the sizes in specific areas.

The at-sea sample data are based on the combined total of a number of individual vessel's single day catches. The individual at-sea samples are larger but cover fewer fishing days than the FSRS data with more variable locations and depths. Therefore, they are more sensitive to the timing of sampling (i.e. early or later times, specific weather or temperature events), as well as trap design, and fishing depth which will vary over the season.

The data used in the comparison are shown in Table 2.1. The numbers of lobsters measured in the FSRS traps often exceeded those measured in at-sea samples.

Results

LFA 27
The lobster sizes in the two sets of data shows a close correspondence in the legal sizes though for some periods larger sizes appear to be more common in the at-sea samples (Fig. 2.3). At the smaller sizes, the specially designed FSRS traps appear to retain more lobsters.

LFA 31a
Like in LFA 27, there is good correspondence between the two data sets at sizes above the legal size (Fig. 2.4). Unlike LFA 27, the size distribution of sublegal sizes in commercial traps was also very similar to that in the FSRS traps.

LFA 33
LFA 33 differs from the previous LFAs in that it is a late fall, winter, and spring fishery with more variable fishing depths over the season. So, while the FSRS traps are in a fixed location, the at-sea samples correspond to the commercial fishing locations that change seasonally (Fig. 2.5).

In addition, a large proportion of the catch is caught during the first 3 weeks of the season so size structures can shift rapidly over this time period. The FSRS data is a sum of the catch over that period while the at-sea samples tend to be in weeks 2-4. Finally, the size at maturity is greater than in LFA 27 or LFA 31a, so berried females would only be observed in the larger sizes.

LFA 33 East - April and May show good correspondence in legal sizes while the FSRS traps showed higher catches in the sublegal sizes (Fig. 2.6). The December sample numbers are low and correspondence is poor.

LFA 33 West - The April and May data shows good correspondence in both legal and smaller sizes (Fig. 2.7). The December data had a poorer correspondence in legal sizes possibly due to due to timing and depth of the at-sea samples.

Conclusions – Sizes in FSRS Traps

The sizes in FSRS traps appear to be a good representation of what is captured in at-sea samples of the commercial catch. In some areas (LFAs 27 and 33), the FSRS traps are better at catching sub-legal sizes, which is the purpose for which they were designed. In other areas (LFA 31a) this difference was not as evident. The best agreement between the two data sets was in LFA 31a, which had the largest at-sea sampling program covering most of the LFA and distributed over the entire season. This suggests that the FSRS data is a good representation of the catch and that the differences observed in the other LFAs was in part due to the lack of sufficient numbers of at-sea samples.

An exception to the above is the fall period in LFA 33. For this LFA and period, the correspondence between the two data sets was not as good. During the fall, the fishery is in deeper water. At-sea samples from this period sample a different portion of the population than the FSRS traps, which are set at shallower depths.

The plots for the sizes of berried females in LFA 33 (Fig. 2.6, 2.7) suggest that larger berried females may be under represented in the FSRS data in April and May. For any analysis of berried females, restricting the comparison to size groups below Size 13 (< 121 mm carapace length (CL)) could reduce the impact of any reduced catchability of larger berried females in the FSRS traps.

2.3. EXPLORATION OF OTHER DATA SOURCES

At the framework, it was suggested that other available data sources should be explored. These included the voluntary logs (e.g. do they have data on catch rate (CPUE) of berried females), the data on ovigerous females in FSRS recruitment traps, and the data for sublegals, legals and ovigerous females in the FSRS data from commercial traps in LFA 33.

2.3.1. LFA 33 FSRS Data from Commercial Traps

Due to problems with the structure of the database, we were only able to plot the positions of fishing locations (Fig. 2.2). If the database can be modified these data can be analyzed to develop a CPUE index and to estimate exploitation using Continuous Change in Ratio (CCIR).

2.3.2. Ovigerous Females in FSRS Recruitment Traps

Here, only the unstandardized CPUEs for LFA 27 as a whole (Fig. 2.8) and by subunit (Fig. 2.9) are presented. The data indicate an increase in the CPUE of ovigerous females overall (Fig. 2.8), and in three of the four subunits (Fig. 2.9). There are outliers in 2006 and 2009 that need to be investigated (Fig. 2.9). The values in the south (SD 7) are lower than the north (SD 1), as might be expected from the larger size at maturity in the south. The upward trend in north central (SD 4) is the weakest.

If the points in Fig 2.8 are averaged by year, they range from 0.21 (n per trap haul) in 1999, to 0.44 in 2006. The median for the period 1999-2009 was 0.27; the median for 2007-2009 was 0.41. These data provide strong evidence of an increase in the abundance of ovigerous females. We have not looked in detail at the sizes of these ovigerous females and from the perspective of overall health of the population a range of sizes of breeders is desirable (DFO 2009).

An objective for the future is to develop a statistical model for these data, and the ovigerous female data from the other assessment units.

Conclusions for indicators of ovigerous female abundance in LFA 27 based on the FSRS recruitment trap data are in Table 2.3.

2.3.3. Ovigerous Female Data in Voluntary Logs

Investigation of these data indicated that a substantial percentage of voluntary logbook keepers have provided data on the numbers of berried females (Table 2.2). Of a total of 1,770 annual fisherman logs kept from 1984-2009, 1,123 (63%) provided data on the number of berried females per year. Plots of the unstandardized annual catch rates for each fisherman (Fig. 2.10) indicate these data are picking up trends observed elsewhere. If the points for LFA 27 in Fig. 2.10 are averaged by year (1999-2009) they range from 0.12 in 1999 to 0.28 in 2007. Median for the period 1999-2009 was 0.19; the median for 2007-2009 was 0.26. A similar increase in ovigerous females CPUE in LFAs 27 and LFA 31a was observed in at-sea sample data (Tremblay et al. 2011).

The CPUE trend and level within LFA 27 (Fig. 2.11) has some similarities and differences when compared to those in the FSRS recruitment trap (Fig. 2.9). The CPUE from the voluntary logs shows an upward trend in all subunits compared to the three subunits in the FSRS data (Fig. 2.9). In addition, the strongest positive trend in the voluntary log berried CPUE is in north central (SD 4); whereas, this trend was weak at best in the FSRS data (Fig. 2.9). The CPUE levels were lower in the voluntary log data, likely because the FSRS traps retain a lot more sublegal ovigerous females than the commercial traps monitored by voluntary log book keepers.

The CPUE level in LFA 33 (Fig. 2.12) is substantially lower than in LFA 27 (<1/5th), presumably primarily because of the higher size at maturity in LFA 33. This difference in ovigerous female CPUE between LFA 27 and 33 has also been demonstrated in FSRS traps (Tremblay et al. 2009). The data suggest a long-term increase in the CPUE of ovigerous females in LFA 33. Much of the observed upward trend is due to low CPUE of berried lobsters prior to 1995; the voluntary logs for the period would need to be examined more closely to be confident that berried females were being recorded from the same locations and with the same precision.

In the LFAs 28-32, there are fewer data, but where the logs were maintained (LFAs 30 and 31), they indicate large increases in berried females CPUE in recent years (Fig. 2.10) and commensurate with the increased recruitment in these areas.

In conclusion, it appears there is high value in the data obtained from the voluntary logs for ovigerous CPUE. These logs should be maintained in the future. An option to consider is for current and future volunteer fishermen to record just the ovigerous females and provide data on total weight of commercial sizes in the mandatory logs.

Conclusions for ovigerous female abundance based on the CPUE in voluntary logs are in Table 2.3.

Table 2.1. Summary of data used to compare sizes of lobsters in FSRS traps with those from at-sea samples. Shown is the number of boats, days and lobsters measured in the FSRS and at-sea sample data for LFA 27, LFA 31a, LFA 33 East and LFA 33 West.

		FSRS		At-sea samples	FSRS	At-sea samples
Area	**Time period**	**Boats**	**Days**	**Days**	**Lobsters measured**	**Lobsters measured**
LFA 27	2004	6	226	8	4601	5147
Little River	2007	5	185	5	5830	1881
North Central	2009	4	143	27	4347	10,960
LFA 31a	2008	6	312	12	25466	11017
	2009	8	426	23	35010	15623
	2010	8	419	14	28104	11930
LFA 33 East	Dec-09	22	307	13	6409	408
	Apr-09	15	136	7	956	594
	May-09	22	413	33	5955	3271
LFA 33 West	Dec-09	23	289	20	34398	1518
	Apr-09	17	193	19	4171	4658
	May-09	19	369	71	12770	21368

Table 2.2. Number of logbook participants providing data on number of berried females captured (in addition to numbers of commercial sized lobsters).

LFA	27 Total	28 Total	29 Total	30 Total	31 Total	32 Total	33 Total	ALL
1984							1	1
1985							6	6
1986					4	2	7	13
1987					5	4	10	19
1988	1				5	5	10	21
1989	2				7	3	10	22
1990	2	1			9	5	8	25
1991	2	1			9	7	11	30
1992	6	1	2	3	6	6	15	39
1993	6	3	3	2	10	11	19	54
1994	10	1	4	1	11	18	19	64
1995	17	1	5	1	8	17	20	69
1996	15		4	2	10	15	17	63
1997	32		3	2	10	11	23	81
1998	28		1	2	7	11	22	71
1999	24		1	2	5	7	21	60
2000	23		1	2	4	7	24	61
2001	19		1	2	4	8	27	61
2002	20		1	2	10	7	23	63
2003	18			2	8	8	22	58
2004	16			2	8	7	22	55
2005	14			2	8	8	20	52
2006	14			2	6	4	19	45
2007	14			2	3	1	19	39
2008	11			2	1		13	27
2009	9			2			13	24
Total	303	8	26	35	158	172	421	1123
Total of all logs 1984-2009	663	9	103	90	230	175	500	1770

Table 2.3. Summary table of Abundance Indicators for ovigerous females based on CPUE in FSRS traps (LFA 27 only) and from CPUE in voluntary logs. No statistical models developed. Categorized as positive ("+") if median for last 3 years is >=120% of the median for 1999-2009; neutral ("N") if mean of last 3 years is 80-120% of median for 1999-2010 and negative ("-") if mean of last 3 years is < 80% of median for 1999-2010.

Characteristic	Indicator/Source	Conclusions	Caveats	Overall status
Abundance of ovigerous females in LFA 27	Ovigerous female CPUE (no per trap haul/fisherman/yr) • LFA 27 FSRS recruitment traps	Overall abundance of ovigerous females increased over the period 1999-2009 • LFA 27 total: upward trend over the last decade in FSRS CPUE. • Median (0.41) for last 3 yr > median for 1999-2009 (=0.27) LFA 27 subunits: increases in 3 of 4 subunits	• Data are means only; no statistical model • Some differences in trend among subunits • CPUE is affected by environmental conditions which have not been accounted for • Analysis does not evaluate size of ovigerous females	+
Abundance of ovigerous females in LFA 27	Ovigerous female CPUE (no per trap haul/fisherman/yr) • Voluntary logs	Overall abundance of ovigerous females increased over the period 1999-2009 • LFA 27 total: upward trend over the last decade in voluntary log CPUE • Median for last 3 yr (0.26) > median for 1999-2009 (=0.19) • LFA 27 subunits: increases in all subunits	• See above	+
Abundance of ovigerous females in LFAs 29-32	Ovigerous female CPUE (no per trap haul/fisherman/yr) • Voluntary logs	Increase in abundance of ovigerous females in some LFAs in recent years	• See above • Data not available for all LFAs	+
Abundance of ovigerous females: LFA 33	Ovigerous female (no per trap haul/fisherman/yr) Voluntary logs	Possible increase since 1980s-1990s; CPUEs lower than in LFAs 27-31.	• See above; • Less data from earlier period for comparison	**N**

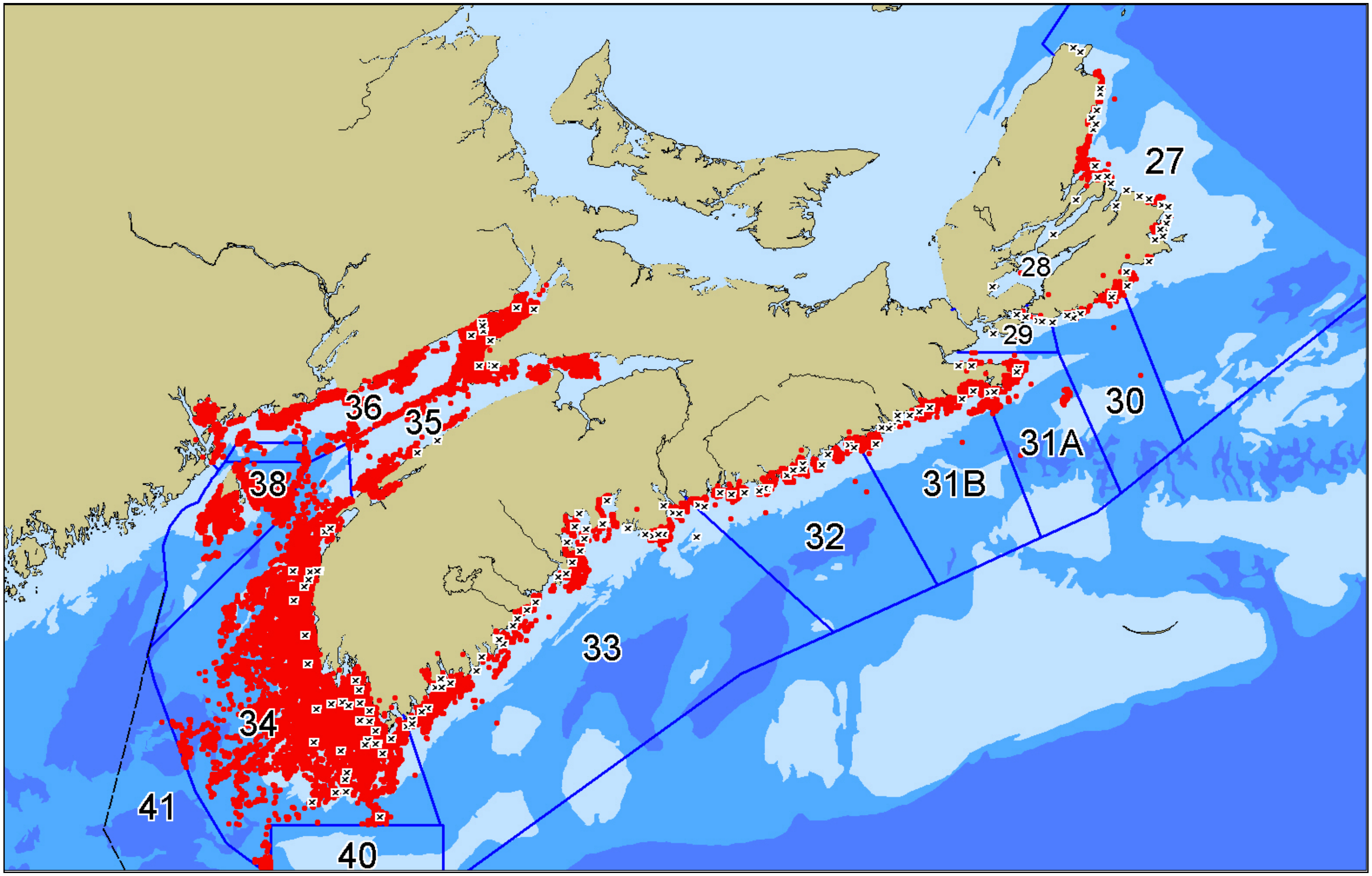


Figure 2.1a. Map of locations of FSRS recruitment traps (black X) and locations during at-sea samples of the commercial catch, 1976 to present (red symbols). FSRS locations are from spring 2009.

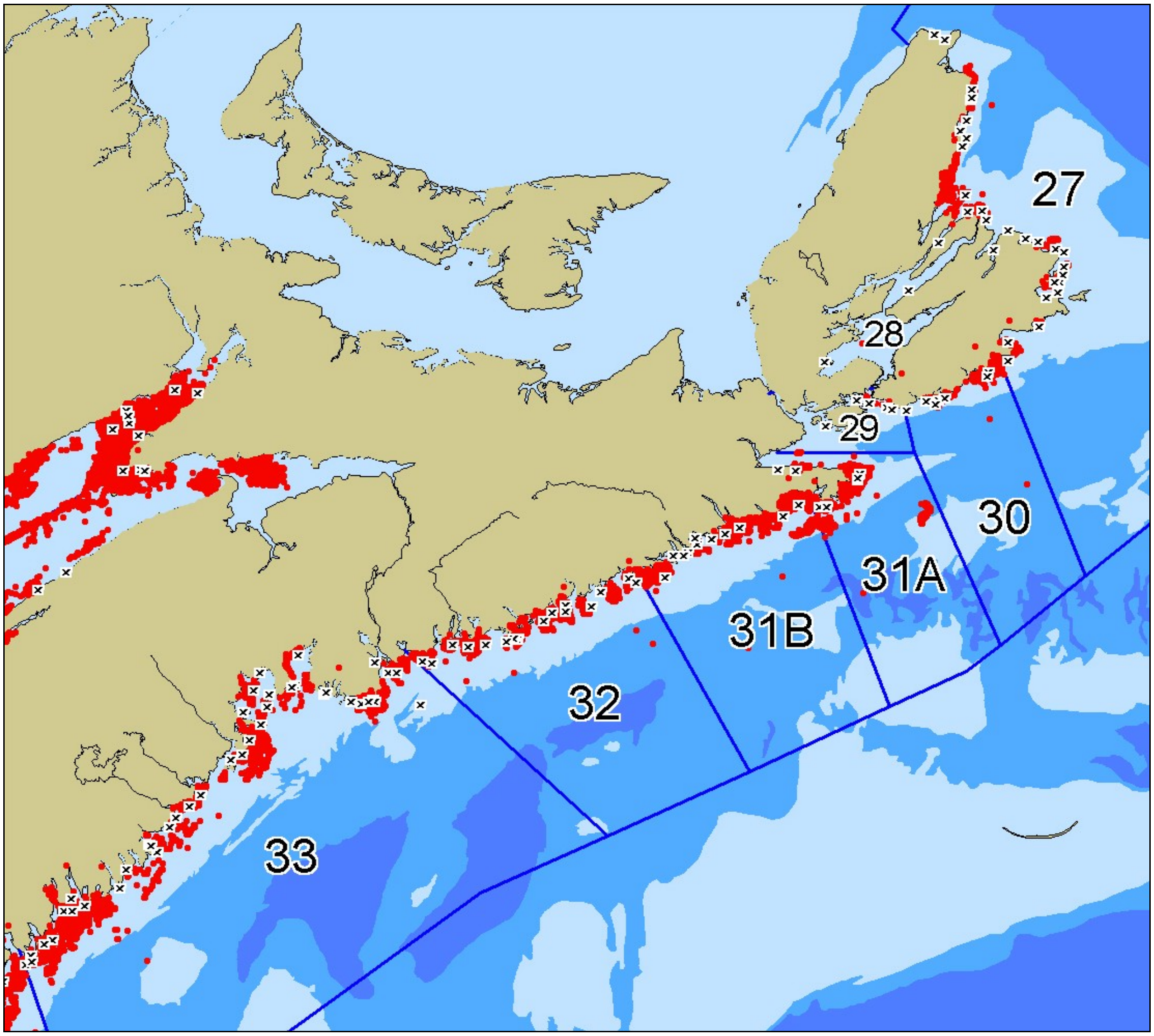


Figure 2.1b. Zoom of Fig. 2.1a. Locations of FSRS recruitment traps (black X) and locations during at-sea samples of the commercial catch.

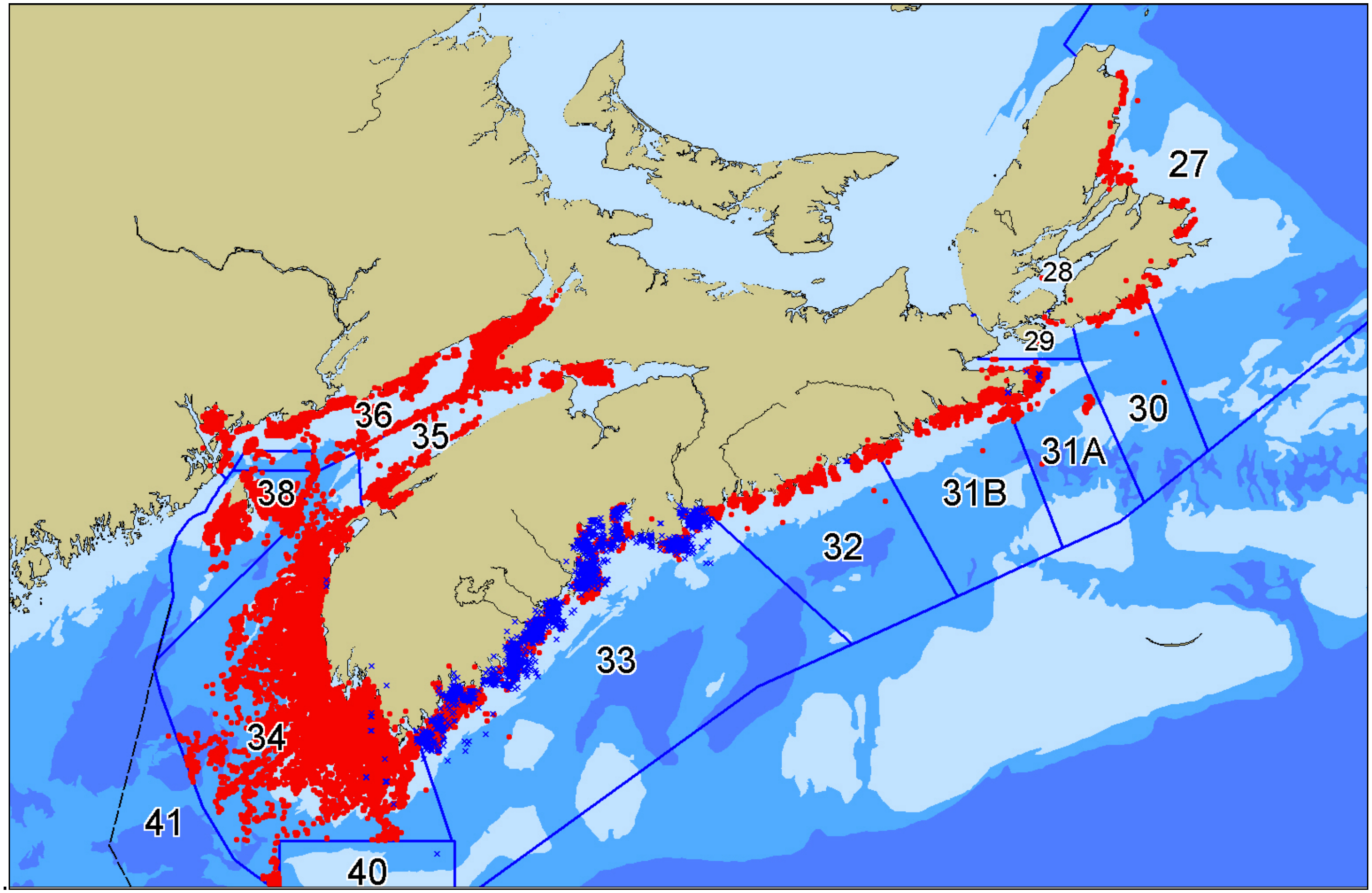


Figure 2.2. Map of locations of FSRS data for commercial traps (LFA 33 mainly) (blue symbols) and of at-sea samples from the commercial catch, 1976 to present (red symbols).

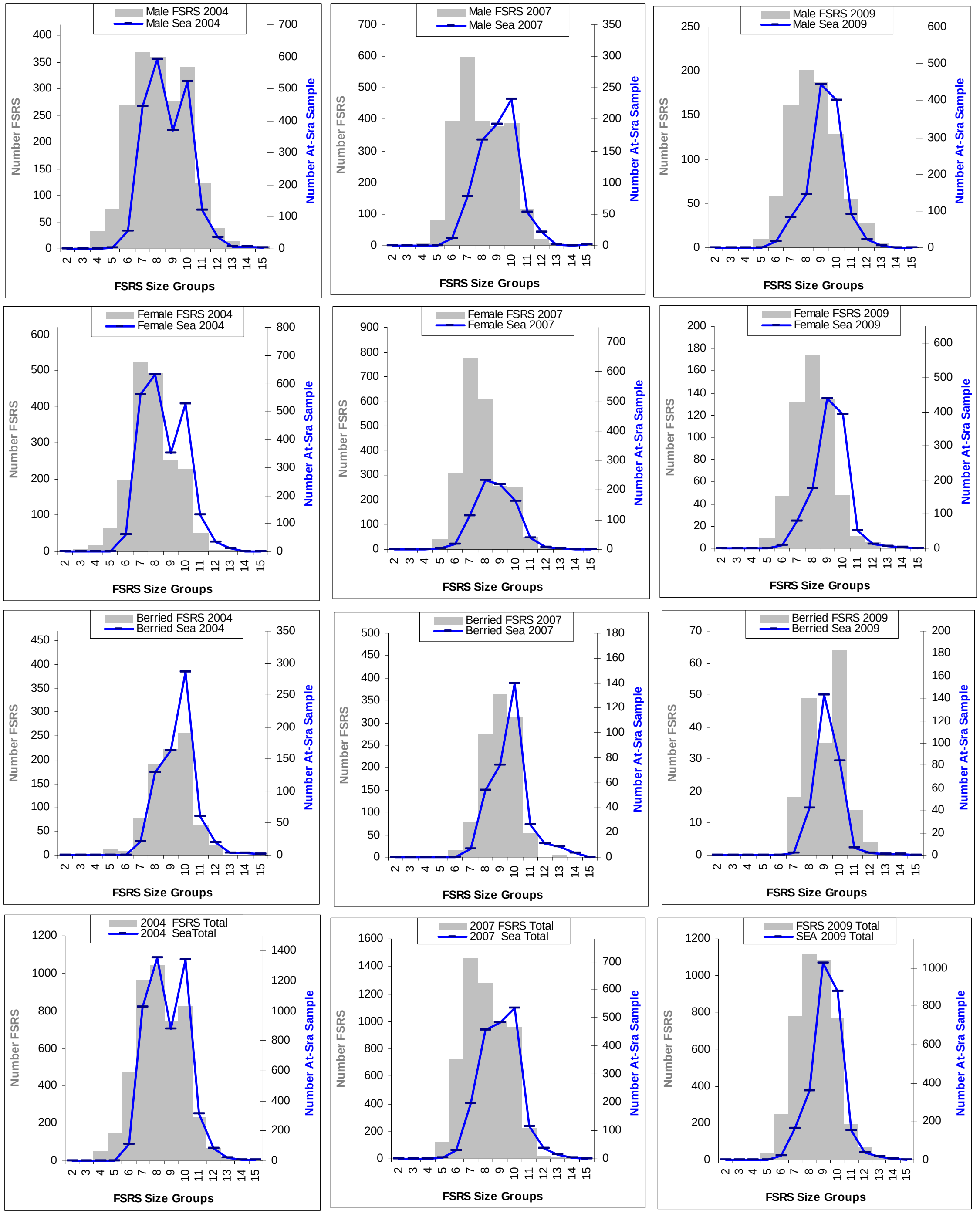


Figure 2.3. LFA 27 data - Comparison of numbers at size obtained in FSRS traps (grey histograms) with numbers at size from at-sea samples (lines). First row is males, second row is females, third row is berried females, and last row is combined. First column shows 2004 samples, second column shows 2007 samples and third column shows 2009 samples.

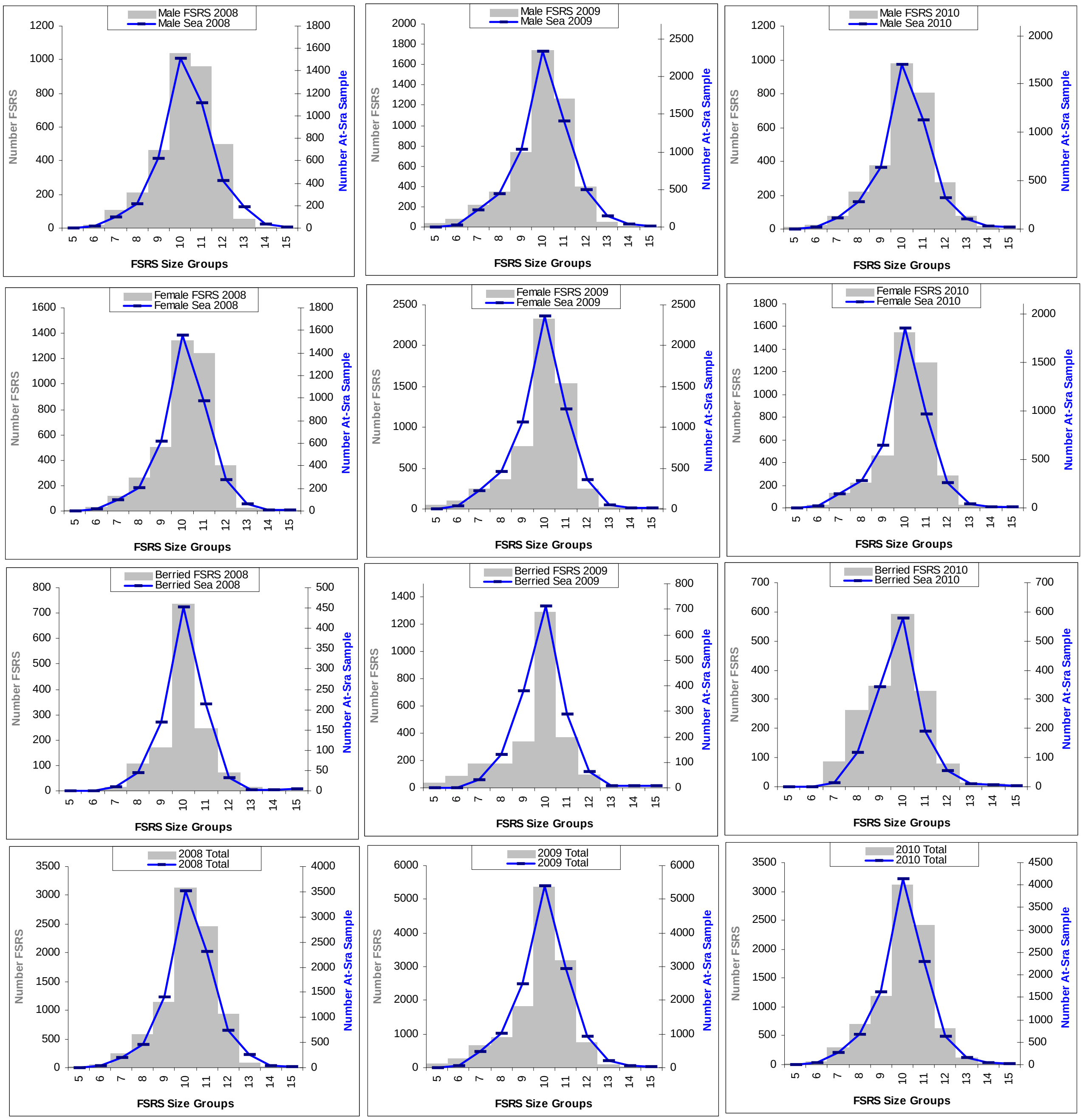


Figure 2.4. LFA 31a data - Comparison of numbers at size obtained in FSRS traps (grey histograms) with numbers at size from at-sea samples (lines). First row is males, second row is females, third row is berried females, and last row is combined. First column shows 2008 samples, second column shows 2009 samples and third column shows 2010 samples.

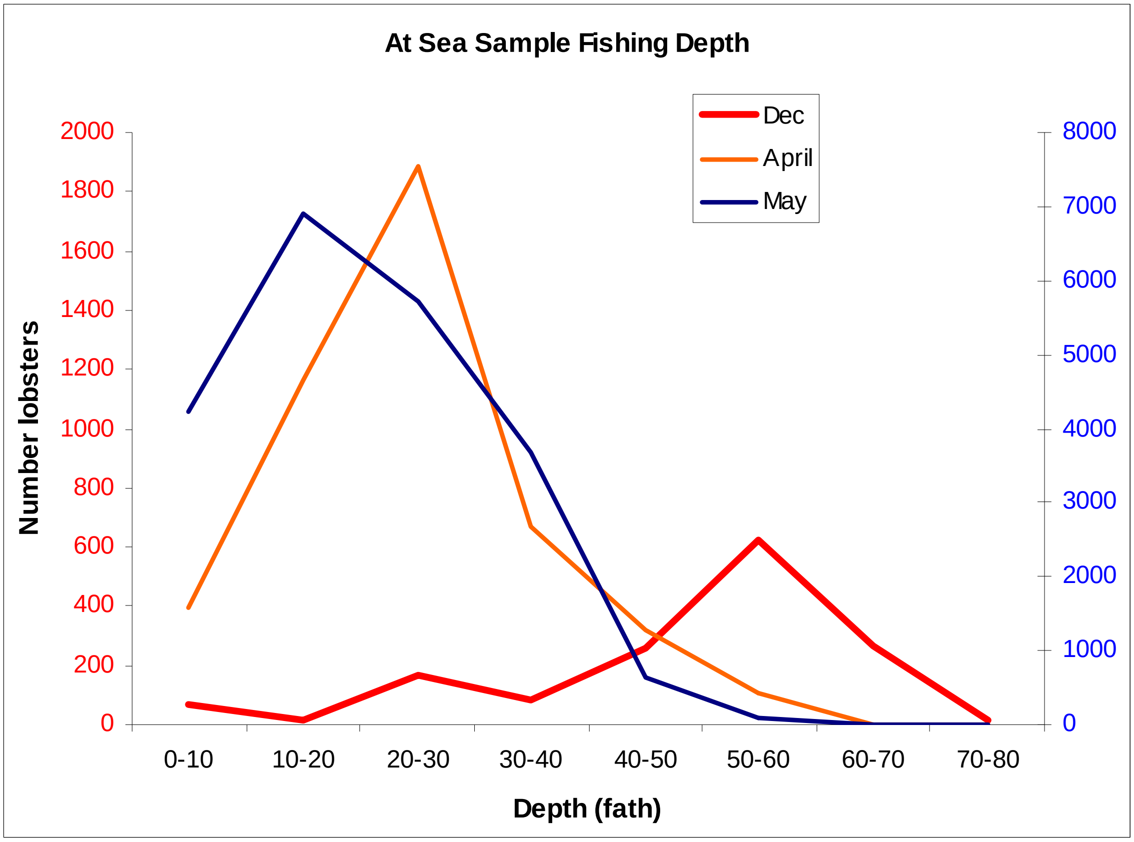


Figure 2.5. Fishing depth during at-sea samples in LFA 33 by month.

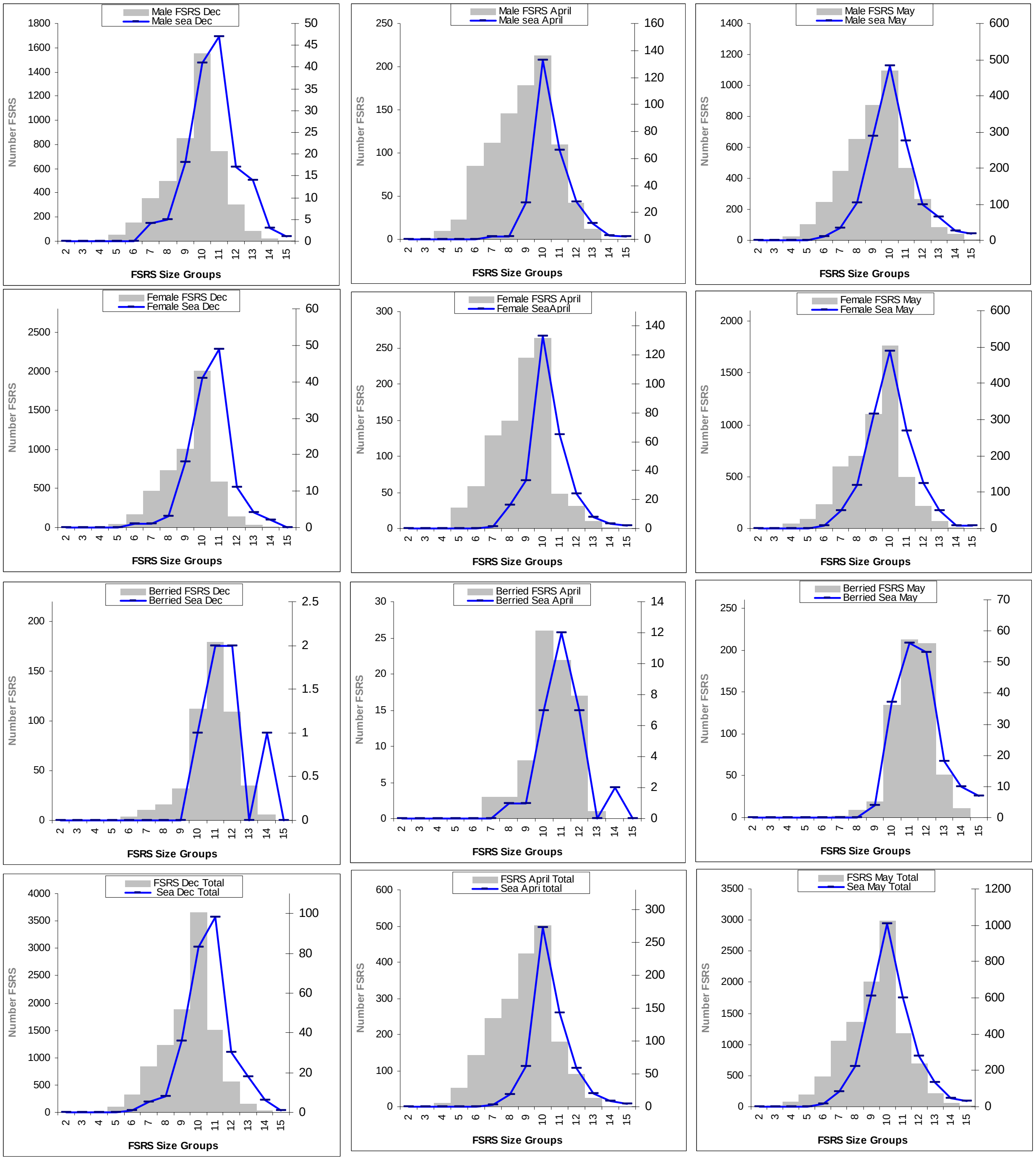


Figure 2.6. LFA 33 East data - Comparison of numbers at size obtained in FSRS traps (grey histograms) with numbers at size from at-sea samples (lines). First row is males, second row is females, third row is berried females, and last row is combined. First column shows December 2008 samples, second column shows April 2009 samples and third column shows May 2009 samples.

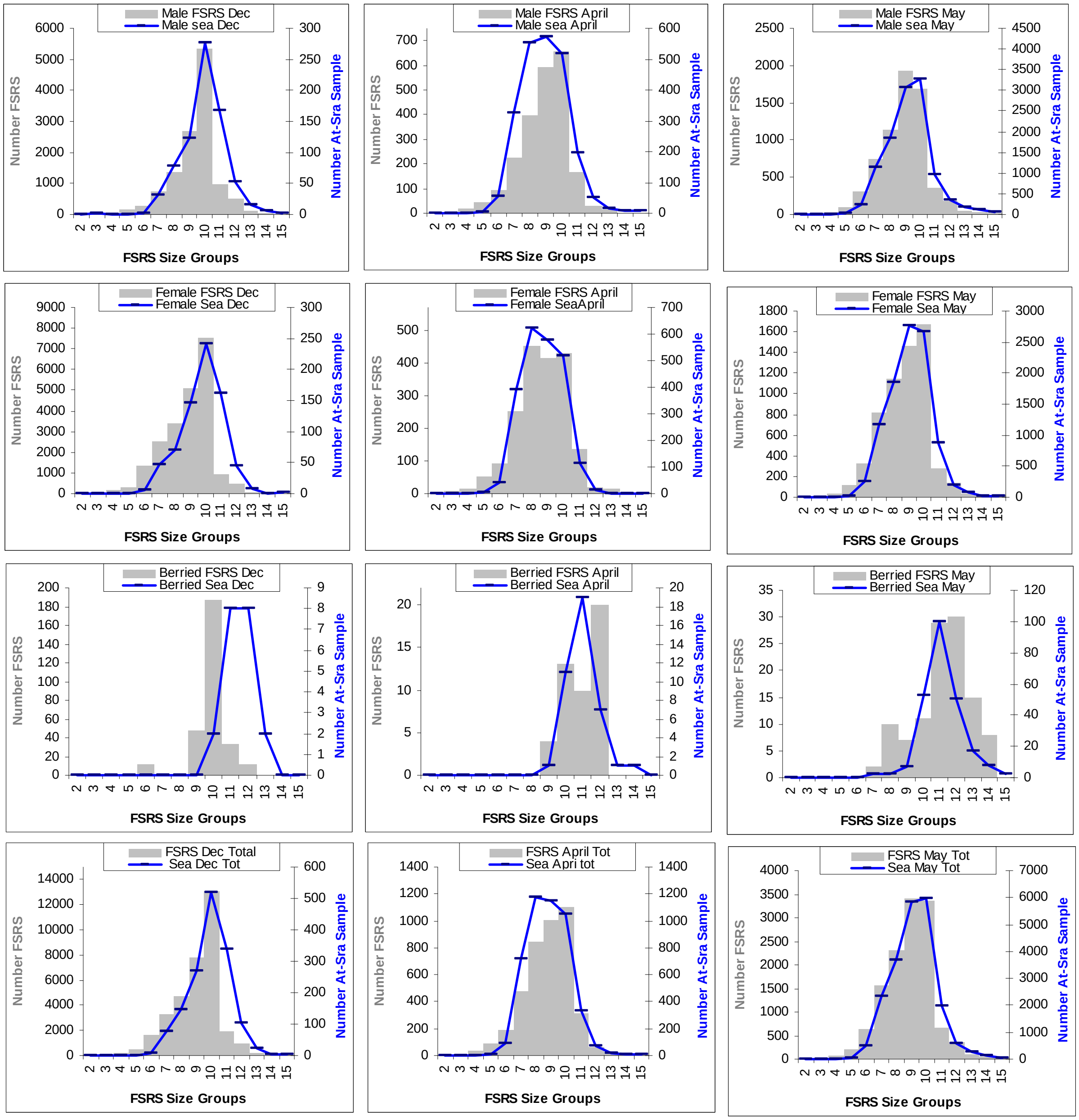


Figure 2.7. LFA 33 West data - Comparison of numbers at size obtained in FSRS traps (grey histograms) with numbers at size from at-sea samples (lines). First row is males, second row is females, third row is berried females, and last row is combined. First column is December 2008, second column is April 2009, and third column is May 2009.

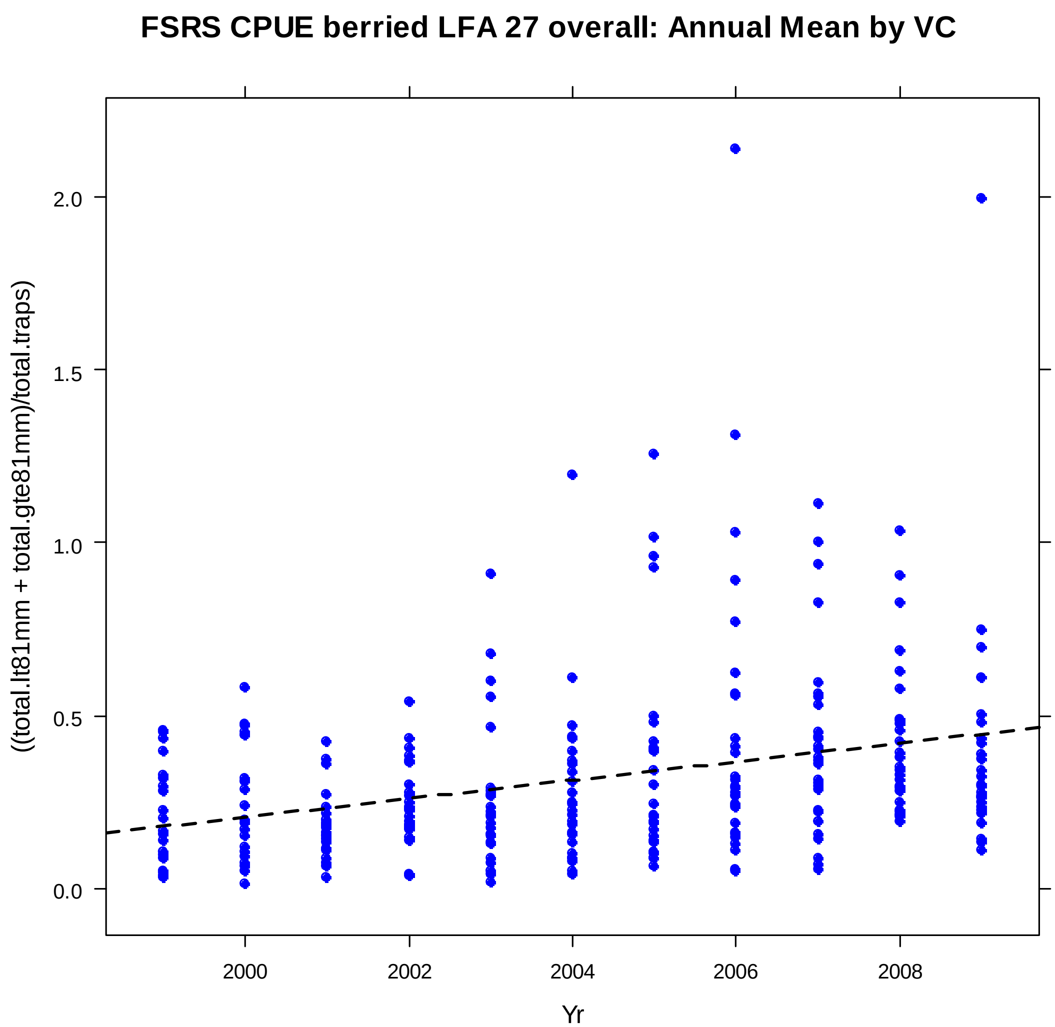


Figure 2.8. Ovigerous female CPUE in FSRS traps in LFA 27 overall, 1999-2009: all sizes. Each point represents the annual CPUE for an individual fisherman (total number of berried/total number of traps hauled). Dashed line is a linear fit to the data.

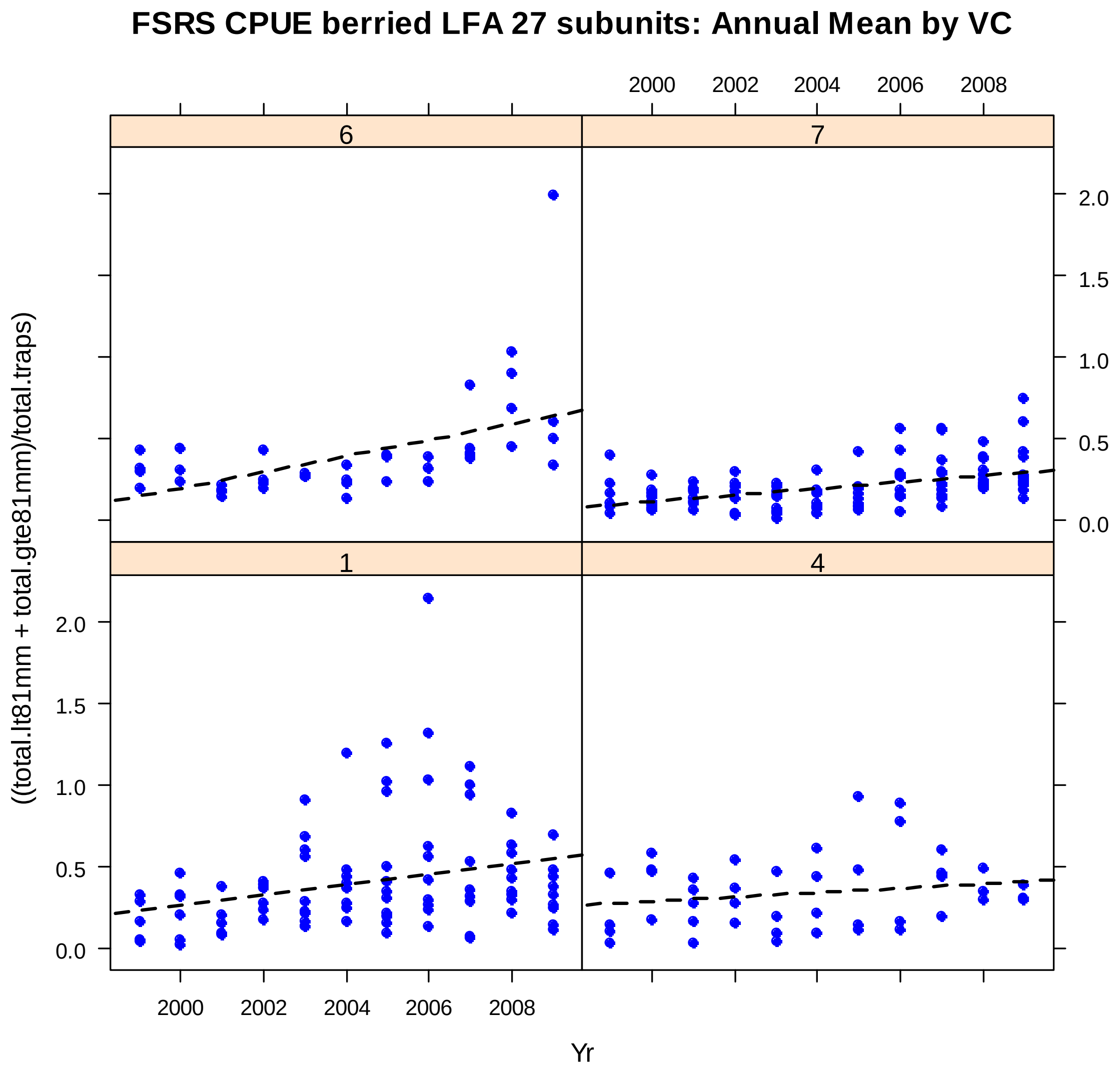


Figure 2.9. Ovigerous female CPUE in FSRS traps in LFA 27 subunits, 1999-2009: all sizes. Each point represents the annual CPUE for an individual fisherman (total number of berried/total number of traps hauled). Dashed line is a linear fit to the data.

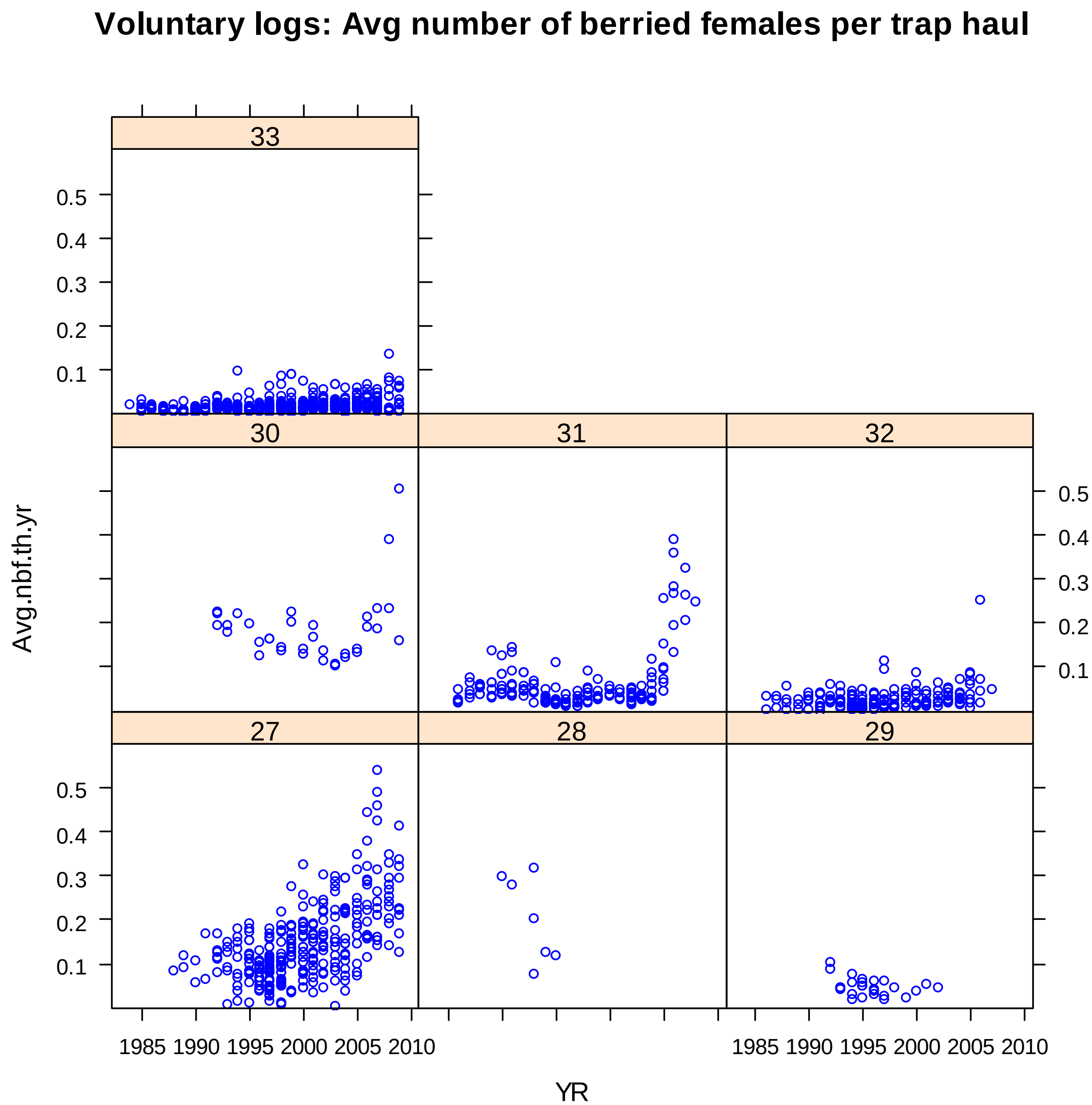


Figure 2.10. Plots of unstandardized CPUE data for berried females from voluntary logs. Each point represents the annual CPUE for an individual fisherman (total number of berried/total number of traps hauled).

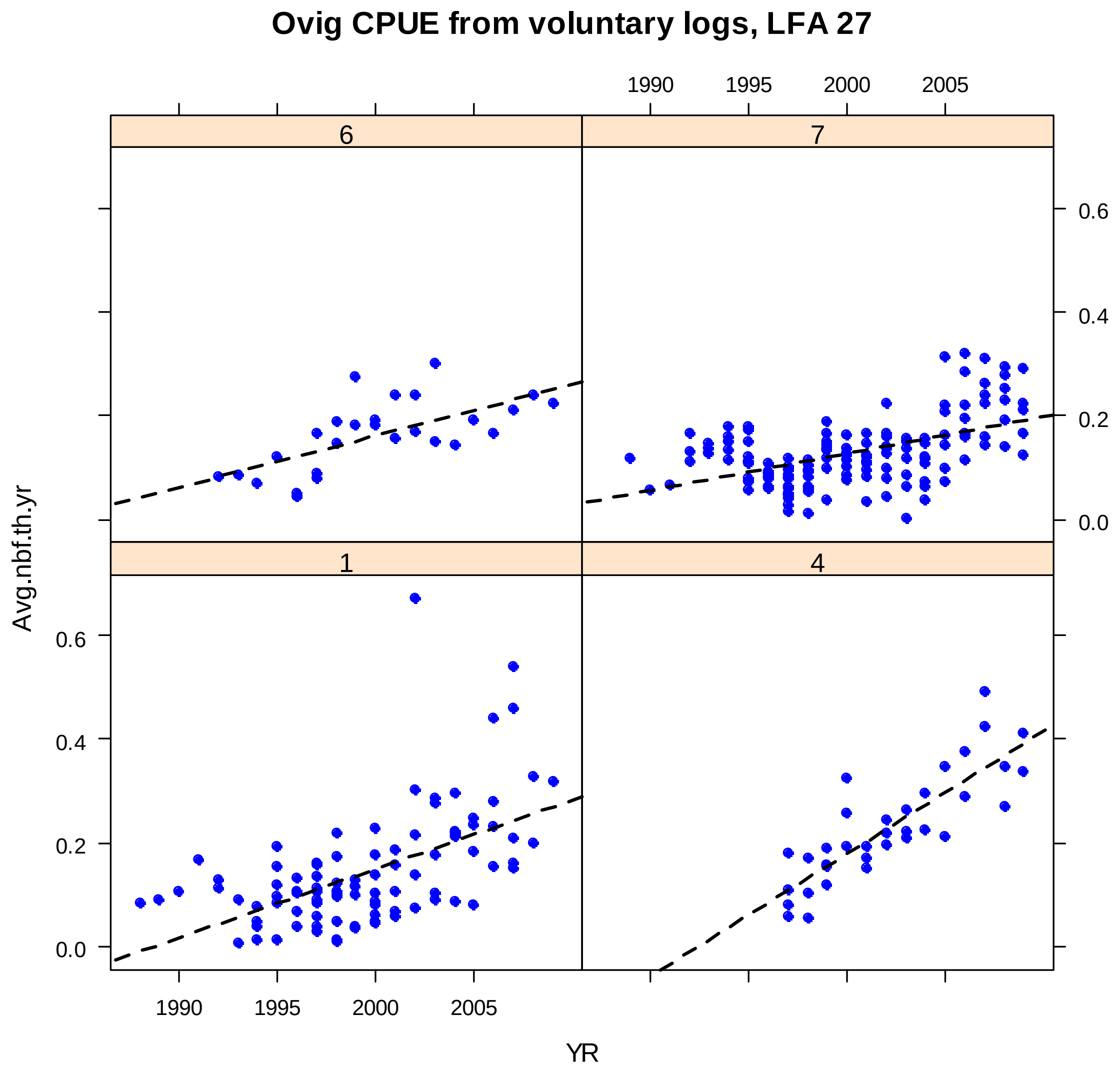


Figure 2.11. Plots of unstandardized CPUE data for berried females from voluntary logs within LFA 27. Each point represents the annual CPUE for an individual fisherman (total number of berried/total number of traps hauled). Dashed line is a linear fit to the data.

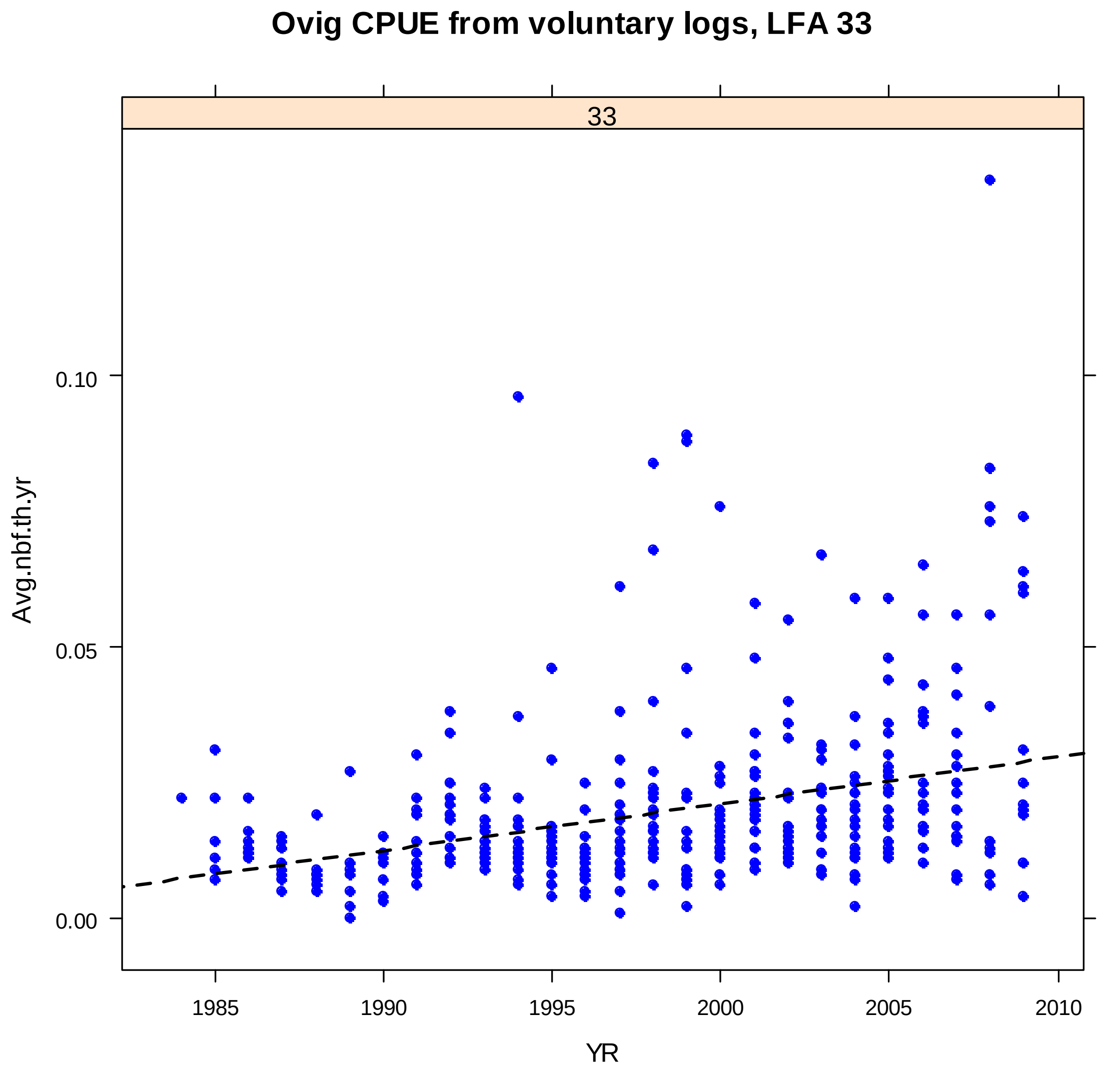


Figure 2.12. Plot of unstandardized CPUE data for berried females from voluntary logs within LFA 33. Each point represents the annual CPUE for an individual fisherman (total number of berried/total number of traps hauled). Dashed line is a linear fit to the data.

3. FISHERY PERFORMANCE INDICATORS

Landings, fishing effort, catch rates (from mandatory commercial and from voluntary commercial logs), and the median sizes in the commercial catch were all deemed indicators of fishery performance at the framework meeting (DFO 2011). These are reviewed below.

3.1. LANDINGS

Landings data are available from various sources since the 1890s, and they have been used historically as an indicator of the state of the fishery. However, landings levels are a function of abundance, level of fishing effort (trap hauls and Soak Over Days), timing of effort, fishing strategy, catchability (environmental, gear efficiency, density), and availability. Changes in any of these can affect landing levels. Thus, changes in landings are not a direct reflection of changes in abundance.

Major changes in effective effort occurred during the 1980s and 1990s (Duggan and Miller 2002) that were brought on by changes in vessels, traps and ship board electronics (i.e. sounders, radar, Loran, Global Positioning System (GPS), mapping). These changes make comparison with older historical landings questionable. However, the long time series available can give indications of general trends and patterns in abundance.

3.1.1. Methods

Landings data were obtained as described in Data Inputs (section 3) of the LFA 27-33 framework document (Tremblay et al. 2011).

Historical landings from 1892-1946 were recorded by county, which do not always correspond with LFA or Statistical Districts. The 1892-2010 data are presented for LFA 27 (Victoria/ Cape Breton County), LFA 29-31 (Richmond/ Guysborough County), and LFA 32-33 (Halifax/ Lunenburg/ Queens/ Shelburne County).

Landings for 1947-2010 are presented by LFA with LFA 31a and 31b combined (LFA 31 divided in 1988).

To classify periods of high and low landings, the landings were divided into quartiles. Values that were less than the 25th percentile of the time series were classified as “negative”, values between the 25th and 75th percentile were classified as “neutral”, and values that were greater than the 75th percentile were classified as “positive”.

Three time periods were examined: 1892-2010, 1947-2010, and 1970-2010. The latter time period was chosen to reflect the more recent fishery following introduction of limited entry and trap limits in 1968.

3.1.2. Results and Discussion

Historical Landings

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 (Fig. 3.1, Table 3.1). During this phase, the fishery was fishing down the accumulated biomass of the previously unfished population. Concerns were raised throughout the Maritimes as early as 1872, when a decline in the average size in the catch was first observed (Venning 1873; Rathbun 1884; Herrick 1897). Over the next 50 years, numerous Government Commissions reviewed the decline and recommended changes in regulations in an attempt to stop further declines (Prince 1899; Wakeham 1909; Knight 1917; MacLean Commission 1928). The landings remained low during the 1930s and early 1940s. Landings rose following WW II and peaking in the mid-1950s then declining throughout the 1960s and 1970s. Landings increased throughout the 1980s as part of a western Atlantic wide pattern that saw landings increase over the entire lobster's range.

While the overall pattern seen in Canadian landings holds for most regions, differences are seen in LFA 27-33 (Fig. 3.2). LFA 27 (Fig. 3.3a) appears to be an exception in that an initial period of high landings followed by a decline is not evident in the data. Landings remained relatively constant through the 1892-1965 period. A decline in the 1970s is evident but less pronounced than in many other areas. Landings then rose rapidly to unprecedented levels during the 1980s and peaked in 1990 followed by a similarly sharp decline before levelling out in 1997. Landings have increased since 2000, with 2009 landings at 56% of the peak of 1990 and 2 times the long term mean 1892-1980.

LFA 28-31 (Fig. 3.3b) exhibited the large decline during the 1890s and early 1900s and was followed by smaller peaks in the early 1930s and mid-1950s. An all time low occurred in the late 1970s. 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, with 2009 landings 4.5 times those of 2004 and almost matching the all time highs of 1895.

LFA 32-33 (Fig. 3.3c) exhibited the large decline during the 1890s and early 1900s and was followed by low landings through the 1930s and 1940s. A small increase is evident in the early 1950s but in the following decades there was a downward trend and all-time lows were reached in the late 1970s. As observed in other lobster areas, landings increased during the 1980s and in LFA 32-33 peaked in 1987. Though landings declined in the early 1990s, they remained above levels observed since the 1920s, and since 2004 they have increased. The 2009 landings are at 1.4 times the peak of 1987 and 16 times the record low of 1978, though still below the all-time highs of the 1890s.

Landings 1947-2010

Figure 3.4 shows the landing trends in each LFA between 1947 and 2010 (2010 landings are preliminary values) and the mean landing levels over the last 10, 25 and 50 years. Figure 3.5 shows the landings grouped by the three assessment units. Tables 3.2 and 3.3 show that in all areas the lowest landings of the time series occurred during the 1970s and with the exception of LFA 27 the highest landings occurred during the last 5 years.

The recent increases in landings are believed to reflect increased abundance, as they are in many cases extremely large and there has been no evidence of a corresponding change in fishing effort prior to the increase. Fishing effort responded to the increased landings and, with the new revenue, fishermen have invested in new vessels and traps.

Peaks and troughs have been observed in many of the regions in the past with both rapid increase and rapid declines in landings. The specific factors controlling abundance and subsequent landings have not been determined.

3.2. FISHING EFFORT

The lobster fishery is a limited entry fishery with a fixed season and trap limits, so the maximum nominal fishing effort is fixed; however, effort levels will vary in response to lobster abundance, economics (i.e. lobster price, fishing cost) and weather.

Effort can be measured as days fished (total and average per fisherman) and trap hauls (TH).

3.2.1. Methods

Daily trap hauls are reported in the logs but not all fishermen reported the trap numbers, especially during the early years of the logbooks. Due to this incomplete recording of TH, total effort was estimated in two ways. First, the reported effort was adjusted using the percentage of total logs records with effort recorded. The second method involved dividing the total landings by the uncorrected catch rate based on records that reported catch and effort in the logs.

Days fished were based on available records in the MARFIS database, and commercial logs and self-reported landings. Total days fished can be biased if not all trips are reported. Days per fishermen is based on the records submitted, and is thus less affected by missing records.

3.2.2. Results and Discussion

The two estimates of TH along with the reported effort are given in Table 3.4 and Figure 3.6. The data show increases in the estimated trap hauls since 2004 with many LFAs peaking in 2008 and either remaining near that level (LFA 31a, 31b, 33) or declining (LFA 27, 29, 30, 32).

Total days fished are given in Figure 3.7; mean days fished per fisherman and SD are given in Figure 3.8. Total days fished and mean days fished per fishermen are either stable or without trend (LFA 27, 28, 30, 32) or have shown an increasing trend (LFA 29, 31a, 31b, 33). Those LFAs where there have been increases are also the LFAs that at the start of the data set were fishing a lower proportion of the available days (Fig. 3.9), and they are also those LFAs that have experienced large increases in landings.

Increases in TH and days fished can contribute to higher landings, but where effort increases occurred after increases in CPUE and landings (e.g. LFA 29 and 31b; see below), it is likely that increased effort was a response to higher abundance.

3.3. CATCH RATE FROM COMMERCIAL LOGS

Commercial logs (also known as Lobster Catch and Settlement Reports) have been mandatory since 2004-05; however, there was a phase-in period in some LFAs with the older Self Reporting landings forms submitted, and in the initial years records were often incomplete. Return rates and completed information have improved and depending upon the LFA, have been good since 2006 or 2007 (see Tremblay et al. 2011). As a result, the time period presently available for analysis is 3 years and not enough for detailed analysis. The data available have been used to calculate an overall seasonal CPUE to allow comparison with other data sources. In future assessments, the logbook results could be standardized as was done in the 2006 LFA 34 assessment, which began using logs in 1998.

3.3.1. Methods – Commercial Logs

Landings and effort data obtained as described in Data Inputs (section 3) of the LFA 27-33 framework document (Tremblay et al. 2011).

3.3.2. Results and Discussion – Commercial Logs

The return rates of the mandatory logbooks have improved in recent years generally being in the 90-100% range (see Tremblay et al. 2011). The records useable for estimating CPUE range from 85-100% depending upon the LFA with LFA 27 at 84-85%, LFA 29 at 95-96%, LFA 30-32 at 97-100% and LFA 33 at 85-86%.

Catch rate (CPUE) calculated from the logbook data and expressed in kg per trap haul are presented in Table 3.5 (LFA 27) Table 3.6 (LFA 28-32) Table 3.7 (LFA 33). These data are displayed graphically in Fig. 3.10 (LFA 27-32) and Fig. 3.11 (LFA 33).

The short time series makes discussion of trends or levels preliminary, but as the time series lengthens, their value will increase. In future assessments, the data will be available for catch rate modeling.

The overall observation is that over the period of time the data are available, CPUE shows few trends. Catch rate varied little in LFAs 27, and 32. LFA 33 was higher in recent years, while LFAs 29, 31a and 31b showed increases in the early part of the time series (2005-2006) and have remained constant since. LFA 30 showed an increasing trend up to 2009. All of these also show a small downturn in 2010.

Plots of catch, effort, and CPUE versus year as well as landings versus effort, and CPUE versus effort are shown in Figure 3.12. Catch rate either shows no relationship to effort levels or higher levels at higher effort levels, which suggests effort increased in response to the higher CPUE. Thus, the recent increases in landings are primarily due to increased CPUE (and presumably abundance) and not to increased fishing effort.

3.4. CATCH RATE FROM VOLUNTARY LOGS

Voluntary logs began in the mid-1980s to provide information on catch rates as the self-reporting logs at the time did not include it. The number of logs recorded increased to a peak in the mid-1990s then declined (Table 3.8). Two areas, LFA 27 and 33 maintained the numbers into recent years and these provide a means to compare the voluntary log catch rates with those of the mandatory logs that began in 2006.

3.4.1. Methods – Voluntary Logs

Landings and effort data from the voluntary log records were obtained as described in section 3.1.

Due to of the declining numbers of voluntary logs in most LFAs, it is not possible to compare the results with the mandatory log records in all LFAs.

Only logs that met the following criteria were used:

- Class A licence

- Fished at least 4 consecutive seasons
- In LFA 33 fished both fall and spring, and in LFA 27 fished all months of the season.

CPUE was calculated by Statistical District by dividing reported landings by reported effort. The CPUE for LFA 27 North and South, and LFA 33 West were calculated using a weighted mean (based on landings) of the CPUE from each SD. CPUE was not calculated for LFA 33 East because too few SD were covered by the voluntary logs.

3.4.2. Results and Discussion – Voluntary Logs

The CPUE from the voluntary logs are presented in Figure 3.13 for LFA 27 (north and south), LFA 31a, LFA 31b, LFA 32, and LFA 33 (East and West). The remaining LFAs had insufficient numbers or time series to present. Where there is overlap of the voluntary and compulsory log data there is generally good agreement in both level and trend. In the future, this may allow the extension of the time series of commercial CPUE using the compulsory log data.

In all the LFAs, a decline in CPUE is observed in the early 1990s followed by increased CPUE. The rate of this increase varies with the largest and most rapid changes observed in LFA 31a and 31b (Fig. 3.13). In this time series, the most current CPUE levels are the highest in LFA 31a, 31b and 32. In LFA 27 and 33, these levels are similar to those of the period of higher landings in the early 1990s.

3.5. MEDIAN SIZE IN THE COMMERCIAL CATCH

The median size of lobsters in port samples was presented in the LFA 27-33 framework assessment (DFO 2011; Tremblay et al. 2011) and, at the time, it was suggested that besides the median size, the Coefficient of Variation (CV) should also be examined as a measure of the spread of sizes in the catch. A larger CV would indicate a wide distribution of sizes while a smaller CV would indicate a narrower range of sizes.

The lobster fishery is heavily based on new recruits. The median size as measured in port samples will be affected by both changes in recruitment and exploitation. Median sizes and CV are presented in Figure 3.14, Figure 3.15, and Table 3.9.

The median sizes in LFA 27 show a continual increase over the time period because of increases in the Minimum Legal Size (MLS). The median sizes in LFA 29 decreased from 1999-2005 but increased 2007-2009. LFA 31a and 31b showed similar decreases but data are lacking for the most recent years. The median sizes in LFA 33 fluctuated without trend.

The CV trended downward in LFA 27 and LFA 29. LFA 31a and 31b were variable. No consistent trend is observed in LFA 32 or 33. The decrease in the CV in these LFAs cannot be explained by the recent increase in recruitment, which has increased the numbers entering the fishery.

3.6. SUMMARY OF PERFORMANCE INDICATORS

Summary tables for performance indicators are provided for LFA 27 in Table 3.10, for LFAs 28-32 in Table 3.11, and for LFA 33 in Table 3.12.

*Table 3.1. Historical lobster landings. All-time high in **Bold**, all-time low underlined.*

Year	LFA27	LFA 28-31	LFA 32-33
1892	770	3252	6598
1893	916	3800	6884
1894	874	3591	7060
1895	1196	**4065**	**7092**
1896	1484	3095	7020
1897	1518	3095	6086
1898	1424	2975	6569
1899	1501	2933	5360
1900	1775	3293	5408
1901	1300	2445	4191
1902	696	2005	5315
1903	1412	1993	4071
1904	1509	1973	4457
1905	1564	2207	5508
1906	1317	1664	4408
1907	844	1365	4102
1908	927	1471	4217
1909	777	1133	3954
1910	983	1367	3374
1911	1129	1384	3942
1912	1114	1506	3471
1913	1214	1339	4014
1914	716	833	2664
1915	843	1085	3648
1916	831	1211	2573
1917	1177	855	2297
1918	836	679	1684
1919	1161	1084	2422
1920	1285	1214	2263
1921	887	695	3034
1922	1135	700	1303
1923	1038	734	1165
1924	715	516	1036
1925	721	833	1727
1926	904	1192	1794
1927	878	1313	1926
1928	862	1371	1704
1929	928	1659	1901
1930	874	1553	2330
1931	959	1718	2404
1932	1330	1918	2195
1933	1166	1466	1488
1934	1049	1255	1746
1935	940	1174	1782
1936	968	1053	1325
1937	936	1034	1647
1938	1069	1041	1279
1939	880	1041	1411
1940	642	850	1459
1941	769	969	1298
1942	744	764	1269
1943	816	716	1608
1944	1014	777	1625
1945	1084	686	2193
1946	1303	738	2301
1947	912	641	1241
1948	962	702	1301
1949	862	766	1392
1950	898	928	1530
1951	1099	1065	1797
1952	964	1197	1894
1953	1081	1323	2002
1954	1162	1413	1819
1955	1245	1394	1683
1956	916	1258	1733
1957	708	1178	1058
1958	838	1008	1154
1959	882	1068	1580
1960	953	916	1544
1961	955	682	1557
1962	970	856	1685
1963	843	807	1775
1964	778	586	1420
1965	899	429	1282
1966	786	386	888
1967	774	356	749
1968	766	266	1016
1969	540	273	1285
1970	713	296	1099
1971	674	370	1262
1972	641	326	810
1973	547	303	672
1974	748	235	736
1975	893	195	622
1976	749	178	468
1977	795	121	436
1978	838	88	266
1979	1014	104	465
1980	975	77	314
1981	1267	150	419
1982	1227	171	518
1983	1658	245	570
1984	1502	312	1184
1985	1721	356	1838
1986	2420	462	2669
1987	2763	602	3052
1988	3072	606	2811
1989	3714	871	2127
1990	**3790**	656	2340
1991	3526	720	2718
1992	2778	675	2153
1993	2458	520	2010
1994	2190	474	2230
1995	2142	462	1614
1996	1616	341	2050
1997	1398	279	2110
1998	1347	334	2413
1999	1425	342	2478
2000	1505	412	2745
2001	1819	473	2954
2002	1395	457	3111
2003	1659	643	2709
2004	1850	800	2244
2005	2036	1448	2922
2006	1966	2352	3157
2007	2024	2904	3665
2008	2849	3495	3303
2009	2178	3778	4231
2010	2568	3209	4033

Table 3.2. Lobster Landings 1947-2010 values that were less than the 25th percentile of the time series were classified as "negative", values between the 25th and 75th percentile were classified as "neutral" and values that were greater than the 75th percentile were classified as "positive" Lowest 3 years are underlined and highest 3 years in ***Bold.***

Year	LFA27	LFA28-29	LFA30	LFA31	LFA32	LFA28-32	SEASON	LFA33	LFA27-33
1947	912	117	103	421	333	974	1946-47	908	2794
1948	962	110	171	421	285	987	1947-48	1016	2965
1949	862	151	164	451	275	1041	1948-49	1117	3020
1950	898	177	162	589	384	1312	1949-50	1146	3356
1951	1099	246	191	628	501	1566	1950-51	1296	3961
1952	964	300	159	738	743	1940	1951-52	1151	4055
1953	1081	254	244	825	587	1910	1952-53	1415	4406
1954	1162	295	251	867	642	2055	1953-54	1177	4394
1955	1245	296	298	800	476	1870	1954-55	1207	4322
1956	916	282	265	711	440	1698	1955-56	1293	3907
1957	708	215	258	705	231	1409	1956-57	827	2944
1958	838	278	217	513	235	1243	1957-58	919	3000
1959	882	444	108	516	247	1315	1958-59	1333	3530
1960	953	285	159	472	360	1276	1959-60	1184	3413
1961	955	211	162	309	228	910	1960-61	1329	3194
1962	970	183	172	501	603	1459	1961-62	1082	3511
1963	843	140	142	525	690	1497	1962-63	1085	3425
1964	778	105	107	374	397	983	1963-64	1023	2784
1965	899	77	77	275	322	751	1964-65	960	2610
1966	786	69	81	236	177	563	1965-66	711	2060
1967	774	54	59	243	200	556	1966-67	549	1879
1968	766	45	52	169	213	479	1967-68	803	2048
1969	540	44	43	186	229	502	1968-69	1056	2098
1970	713	43	40	213	263	559	1969-70	836	2108
1971	674	59	48	263	276	646	1970-71	986	2306
1972	641	61	43	222	194	520	1971-72	616	1777
1973	547	56	29	218	187	490	1972-73	485	1522
1974	748	43	30	162	141	376	1973-74	595	1719
1975	893	39	37	119	91	286	1974-75	531	1710
1976	749	29	39	110	86	264	1975-76	382	1395
1977	795	24	29	68	84	205	1976-77	352	1352
1978	838	20	20	48	53	141	1977-78	213	1192
1979	1014	34	19	51	49	153	1978-79	416	1583
1980	975	23	13	41	66	143	1979-80	248	1366
1981	1267	45	35	70	56	206	1980-81	363	1836
1982	1227	50	27	94	70	241	1981-82	448	1916
1983	1658	63	62	120	109	354	1982-83	461	2473
1984	1502	74	69	169	140	452	1983-84	1044	2998
1985	1721	113	60	183	180	536	1984-85	1658	3915
1986	2420	154	85	223	284	746	1985-86	2385	5551
1987	2763	200	99	303	258	860	1986-87	2794	6417
1988	3072	203	77	326	222	828	1987-88	2589	6489
1989	**3714**	257	132	482	239	1110	1988-89	1888	6712
1990	**3790**	172	119	365	303	959	1989-90	2037	6786
1991	**3526**	168	151	401	298	1018	1990-91	2420	6964
1992	2778	150	167	358	304	979	1991-92	1849	5606
1993	2458	104	132	284	279	799	1992-93	1731	4988
1994	2190	104	130	240	262	736	1993-94	1968	4894
1995	2141	107	126	229	219	681	1994-95	1395	4218
1996	1616	75	90	176	225	566	1995-96	1825	4007
1997	1398	51	80	148	243	522	1996-97	1867	3768
1998	1347	64	70	200	309	643	1997-98	2104	4093
1999	1425	55	70	217	316	658	1998-99	2162	4239
2000	1505	59	54	299	448	860	1999-00	2297	4656
2001	1819	71	98	304	433	906	2000-01	2521	5245
2002	1395	65	79	313	358	815	2001-02	2753	4963
2003	1659	138	73	432	389	1032	2002-03	2320	5011
2004	1850	198	84	518	289	1089	2003-04	1955	4894
2005	2036	411	112	925	403	1852	2004-05	2519	6407
2006	1966	668	187	1497	602	2954	2005-06	2556	7476
2007	2024	800	216	1888	632	3535	2006-07	**3033**	8593
2008	2849	**1089**	**413**	**1993**	**704**	**4199**	2007-08	2599	**9647**
2009	2178	**1099**	**452**	**2227**	**829**	**4607**	2008-09	**3402**	**10187**
2010	2568	**926**	**371**	**1912**	**657**	**3866**	2009-10	**3376**	**9810**

*Table 3.3. Lobster Landings 1970-2010 values that were less than the 25th percentile of the time series were classified as "negative", values between the 25th and 75th percentile were classified as "neutral" and values that were greater than the 75th percentile were classified as "positive" Lowest 3 years are underlined and highest 3 years in **Bold.***

Year	LFA27	LFA28-29	LFA30	LFA31	LFA32	LFA28-32
1970	713	43	40	213	263	559
1971	674	59	48	263	276	646
1972	641	61	43	222	194	520
1973	547	56	29	218	187	490
1974	748	43	30	162	141	376
1975	893	39	37	119	91	286
1976	749	29	39	110	86	264
1977	795	24	29	68	84	205
1978	838	20	20	48	53	141
1979	1014	34	19	51	49	153
1980	975	23	13	41	66	143
1981	1267	45	35	70	56	206
1982	1227	50	27	94	70	241
1983	1658	63	62	120	109	354
1984	1502	74	69	169	140	452
1985	1721	113	60	183	180	536
1986	2420	154	85	223	284	746
1987	2763	200	99	303	258	860
1988	3072	203	77	326	222	828
1989	**3714**	257	132	482	239	1110
1990	**3790**	172	119	365	303	959
1991	**3526**	168	151	401	298	1018
1992	2778	150	167	358	304	979
1993	2458	104	132	284	279	799
1994	2190	104	130	240	262	736
1995	2141	107	126	229	219	681
1996	1616	75	90	176	225	566
1997	1398	51	80	148	243	522
1998	1347	64	70	200	309	643
1999	1425	55	70	217	316	658
2000	1505	59	54	299	448	860
2001	1819	71	98	304	433	906
2002	1395	65	79	313	358	815
2003	1659	138	73	431	389	1031
2004	1850	198	84	518	289	1089
2005	2036	411	112	925	403	1852
2006	1966	668	187	1497	602	2954
2007	2024	800	216	1888	632	3535
2008	2849	**1089**	**413**	**1993**	**704**	**4199**
2009	2178	**1099**	**452**	**2227**	**829**	**4607**
2010	2568	**926**	**371**	**1912**	**657**	**3866**

SEASON	LFA33	LFA27-33
1969-70	836	2108
1970-71	986	2306
1971-72	616	1777
1972-73	485	1522
1973-74	595	1719
1974-75	531	1710
1975-76	382	1395
1976-77	352	1352
1977-78	213	1192
1978-79	416	1583
1979-80	248	1366
1980-81	363	1836
1981-82	448	1916
1982-83	461	2473
1983-84	1044	2998
1984-85	1658	3915
1985-86	2385	5551
1986-87	2794	6417
1987-88	2589	6489
1988-89	1888	6712
1989-90	2037	6786
1990-91	2420	6964
1991-92	1849	5606
1992-93	1731	4988
1993-94	1968	4894
1994-95	1395	4218
1995-96	1825	4007
1996-97	1867	3768
1997-98	2104	4093
1998-99	2162	4239
1999-2000	2297	4656
2000-01	2521	5245
2001-02	2753	4963
2002-03	2320	5011
2003-04	1955	4894
2004-05	2519	6407
2005-06	2556	7476
2006-07	**3033**	8593
2007-08	2599	**9647**
2008-09	**3402**	**10187**
2009-2010	**3377**	**9810**

Table 3.4. Catch, effort and CPUE from commercial logs (effort corrected for % of logs with TH included).

	Log CPUE	Log Landings (mt)	Adjusted Log Effort (THX1000)
LFA 27			
2004	0.33	1,735	4,997
2005	0.36	1,919	5,729
2006	0.44	1,820	4,754
2007	0.44	1,910	5,215
2008	0.48	2,674	5,831
2009	0.41	2,130	5,569
2010	0.49	2,083	4,550
LFA 29			
2005	0.71	411	441
2006	1.18	654	534
2007	1.32	772	590
2008	1.33	1,043	811
2009	1.37	1,036	744
2010	1.23	796	633
LFA 30			
2005	0.61	112	200
2006	0.75	187	207
2007	1.33	215	155
2008	1.69	399	237
2009	1.89	462	241
2010	1.69	357	206
LFA 31A			
2005	0.66	424	726
2006	0.92	596	733
2007	1.05	778	741
2008	1.12	925	822
2009	1.13	951	830
2010	1.04	862	824
LFA 31B			
2005	0.56	506	890
2006	0.97	753	872
2007	1.10	948	929
2008	1.09	1,006	920
2009	1.26	1,207	967
2010	1.01	944	939
LFA 32			
2005	0.31	403	1,259
2006	0.43	601	1,332
2007	0.41	620	1,442
2008	0.44	687	1,600
2009	0.48	776	1,616
2010	0.42	611	1,446
LFA 33			
2005-2006	0.36	2,596	7,248
2006-2007	0.44	3,040	7,097
2007-2008	0.34	2,574	7,896
2008-2009	0.44	3,478	8,067
2009-2010	0.46	3,429	7,782

Table 3.5. LFA 27 Catch per unit effort (Kg/Trap Haul) by season and LFA 27 sub unit, 2005 to 2010.

YEAR	Average CPUE		CPUE by Totals		% RECORDS INCLUDED
	NORTH	SOUTH	NORTH	SOUTH	
2004	0.40	0.29	0.41	0.28	3%
2005	0.42	0.33	0.42	0.32	17%
2006	0.52	0.42	0.52	0.39	46%
2007	0.46	0.43	0.46	0.43	52%
2008	0.48	0.48	0.49	0.47	89%
2009	0.41	0.40	0.42	0.40	85%
2010	0.48	0.49	0.49	0.49	84%

Table 3.6. LFA 28-32 Catch per unit effort (Kg/Trap Haul) by season 2005 to 2010.

YEAR	LFA 28		
	average CPUE	CPUE by totals	% RECORDS INCLUDED
2005	0.28	0.28	9%
2006	0.44	0.43	36%
2007	no data meets criteria		
2008	0.31	0.31	73%
2009	0.31	0.30	93%
2010	0.24	0.23	100%
YEAR	LFA 29		
	average CPUE	CPUE by totals	% RECORDS INCLUDED
2005	0.71	0.75	7%
2006	1.18	1.18	40%
2007	1.32	1.33	60%
2008	1.33	1.33	96%
2009	1.37	1.36	96%
2010	1.23	1.24	95%
YEAR	LFA 30		
	average CPUE	CPUE by totals	% RECORDS INCLUDED
2005	0.61	0.61	5%
2006	0.75	0.75	32%
2007	1.33	1.36	52%
2008	1.69	1.69	98%
2009	1.89	1.91	100%
2010	1.69	1.71	100%

Table 3.6, continued. LFA 28-32 Catch per unit effort (Kg/Trap Haul) by season 2005 to 2010.

YEAR	LFA 31A		
	average CPUE	CPUE by totals	% RECORDS INCLUDED
2005	0.65	0.67	11%
2006	0.92	0.90	78%
2007	1.05	1.06	88%
2008	1.12	1.13	98%
2009	1.13	1.15	99%
2010	1.04	1.05	99%
YEAR	LFA 31B		
	average CPUE	CPUE by totals	% RECORDS INCLUDED
2005	0.56	0.56	6%
2006	0.97	0.97	84%
2007	1.10	1.11	86%
2008	1.09	1.10	97%
2009	1.26	1.27	97%
2010	1.01	1.02	97%
YEAR	LFA 32		
	average CPUE	CPUE by totals	% RECORDS INCLUDED
2005	0.31	0.31	16%
2006	0.43	0.44	70%
2007	0.41	0.41	72%
2008	0.44	0.44	93%
2009	0.48	0.49	97%
2010	0.42	0.43	96%

Table 3.7. LFA 33 Catch per unit effort (Kg/Trap Haul) by season, period, and LFA 33 sub unit, 2005-06 to 2009-10.

SEASON	Average CPUE						CPUE by Totals						% RECORDS INCLUDED
	EAST			WEST			EAST			WEST			
	FALL	WINTER	SPRING	FALL	WINTER	SPRING	FALL	WINTER	SPRING	FALL	WINTER	SPRING	
2005-06	0.42	0.17	0.21	0.65	0.28	0.22	0.43	0.17	0.21	0.656	0.27	0.22	60.7%
2006-07	0.52	0.17	0.19	0.85	0.29	0.21	0.54	0.18	0.19	0.855	0.30	0.21	71.2%
2007-08	0.45	0.15	0.24	0.62	0.21	0.26	0.45	0.15	0.25	0.608	0.20	0.26	88.3%
2008-09	0.58	0.18	0.25	0.88	0.27	0.28	0.62	0.19	0.26	0.909	0.27	0.28	86.5%
2009-10	0.57	0.16	0.26	1.06	0.27	0.33	0.60	0.17	0.26	1.095	0.28	0.33	85.1%

Table 3.8. Number of voluntary logbook participants, 1981 to 2009, LFA 27 to 32.

Year	LFA 27	LFA 28	LFA 29	LFA 30	LFA 31	LFA 32	LFA 33	Total
1981	1							1
1982	1							1
1983	1							1
1984	1						6	7
1985	3			2	1	1	10	17
1986	5		3	2	7	3	11	31
1987	5		3	2	10	4	18	42
1988	7		4	2	11	5	15	44
1989	9		5	2	12	3	15	46
1990	9	1	4	2	15	5	12	48
1991	8	1	5	2	15	7	13	51
1992	27	1	8	7	12	6	17	78
1993	43	3	9	6	16	11	21	109
1994	48	2	11	6	17	18	21	123
1995	53	1	8	6	13	17	23	121
1996	50		7	7	13	15	20	112
1997	48		6	7	13	11	26	111
1998	46		5	4	9	11	25	100
1999	37		5	4	7	7	23	83
2000	36		5	4	5	7	27	84
2001	35		4	4	6	8	30	87
2002	34		3	4	11	7	26	85
2003	33		2	4	9	8	25	81
2004	28		1	3	9	8	24	73
2005	24		1	2	9	8	22	66
2006	22		1	2	6	4	21	56
2007	21		1	2	3	1	21	49
2008	17		1	2	1		14	35
2009	14		1	2			14	31

Table 3.9. Summary of port sample data listing, count of lobsters measured, mean, median, minimum, maximum and the coefficient of variation.

LFA 27	**Count**	**Mean**	**Median**	**Min**	**Max**	**CV**
1990	3063	81.3	80	67	150	0.12
1991	3712	84.5	83	69	148	0.11
1992						
1993						
1994	449	81.1	80	70	117	0.10
1995	1131	91.6	88	70	146	0.16
1996	13373	80.9	79	69	160	0.12
1997	10937	80.9	79	68	160	0.12
1998	9633	81.9	80	66	148	0.12
1999	9679	82.8	80	71	170	0.13
2000	9543	82.5	81	72	172	0.11
2001	8129	84.1	82	73	160	0.11
2002	4192	85.5	83	76	170	0.12
2003	4944	85.6	83	76	161	0.11
2004	3067	85.8	83	76	167	0.12
2005	1657	84.8	83	76	149	0.10
2006						
2007	2275	84.4	83	76	148	0.08
2008	4343	87.0	85	77	160	0.09
2009	4007	88.0	86	81	173	0.09
LFA 29	**Count**	**Mean**	**Median**	**Min**	**Max**	**CV**
1990	873	92.4	90	81	141	0.11
1991	858	93.6	90	81	164	0.12
1992	351	93.4	90	81	149	0.12
1993	1493	96.0	92	81	173	0.14
1994	2267	98.2	93	81	164	0.15
1995	1115	99.6	92	81	177	0.17
1996	1637	98.9	92	81	175	0.17
1997	1369	97.6	91	81	184	0.17
1998	7141	100.2	95	81	171	0.16
1999	1326	102.6	95	82	194	0.19
2000	3999	98.0	94	82	182	0.15
2001	1330	98.5	95	84	168	0.14
2002	1133	97.8	94	84	167	0.12
2003	1645	94.7	92	84	170	0.12
2004	1445	91.4	89	84	148	0.09
2005	1010	91.9	90	84	172	0.09
2006						
2007	519	96.5	95	84	155	0.10
2008	551	96.6	94	84	139	0.10
2009	2586	95.2	93	84	151	0.09
LFA 31A	**Count**	**Mean**	**Median**	**Min**	**Max**	**CV**
1990	710	95.4	92	81	158	0.13
1991	596	96.3	92.5	81	165	0.14
1992	587	95.1	92	81	150	0.12
1993	681	94.9	92	81	179	0.12
1994	666	96.4	93	81	182	0.14
1995						
1996	332	115.5		82	162	
1997						
1998	2281	97.5	93	83	170	0.13
1999	205	108.5	107	86	149	0.13
2000	1136	97.6	94	86	157	0.12
2001	712	103.2	102	86	169	0.12
2002	1711	97.9	95	86	169	0.11
2003	1618	95.4	92	86	172	0.11
2004	3340	94.9	92	86	195	0.10
2005	1431	92.5	91	84	152	0.08
2006	1315	97.4	95	84	166	0.11
2007	923	95.4	92	84	182	0.13

Table 3.9, continued. Summary of port sample data listing, count of lobsters measured, mean, median, minimum, maximum and the coefficient of variation.

LFA 31B	**Count**	**Mean**	**Median**	**Min**	**Max**	**CV**
1990	476	95.4	91	81	159	0.15
1991	45	117.9	113	100	169	0.12
1992	634	92.9	91	81	137	0.09
1993	658	94.3	91	81	180	0.13
1994	736	93.0	90	81	167	0.12
1995						
1996	789	96.8	92	81	173	0.15
1997						
1998	706	95.0	92	84	151	0.12
1999	513	98.5	96	82	143	0.13
2000	1449	92.5	90	82	160	0.11
2001	780	94.8	93	82	147	0.11
2002	688	92.51	91	82	145	0.09
2003	994	92.7	89	82	170	0.12
2004	1385	89.7	88	82	150	0.08
2005						
2006	615	93.9	91	82	162	0.12
2007	374	95.0	93	82	137	0.10
LFA 32	**Count**	**Mean**	**Median**	**Min**	**Max**	**CV**
1990	688	91.7	90	81	146	0.10
1991	516	95.7	93	81	165	0.13
1992	532	93.4	90	81	171	0.12
1993	707	93.1	91	81	163	0.11
1994	700	91.3	89	81	174	0.10
1995	228	89.6	89	81	140	0.09
1996	635	92.7	90	81	162	0.11
1997						
1998	597	92.6	90	81	180	0.12
1999	1292	97.4	94	82	170	0.14
2000	1694	96.1	93	82	161	0.13
2001	1387	93.2	91	82	161	0.10
2002	1523	95.0	92	82	152	0.11
2003	1553	95.5	92	82	161	0.12
2004	1198	95.9	92	82	158	0.13
2005						
2006	356	100.1	94	82	149	0.16
2007	631	91.4	90	82	127	0.07

Table 3.10. Summary table of Fishery Performance indicators for LFA 27. Categorized as positive ("+") if mean of overall index for last 3 years is >=120% of the median for 1999-2010; neutral ("N") if mean of last 3 years is 80-120% of median for 1999-2010 and negative if mean of last 3 years is < 80% of median for 1999-2010.

Characteristic	Indicator/ Source	Conclusions	Caveats	Overall status
1Historical Landings	Landings from sales slips, self reporting logs, mandatory logs	Landings remained relatively constant through the 1892-1965 period. A decline in the 1970s is evident but less pronounced than in many other areas. Landings rose rapidly to unprecedented levels during the 1980s and peaked in 1990 followed by a sharp decline before levelling out in 1997. Landings have increased since 2000, with 2009 landings at 56% of the peak of 1990 and 2 times the long term mean 1892-1980. Landings were historically stable with increases and greater variability since 1980.	Landing levels are a function of abundance, level of fishing effort (trap hauls and Soak Over Days - SOD), timing of effort, fishing strategy, catchability (environmental, gear efficiency, density, and lobster movements), and the distribution of animals and effort. Changes in any of these can affect landing levels. Thus, changes in landings are not a direct reflection of changes in abundance.	+
2 Recent Landings	Landings from sales slips, self reporting logs, mandatory logs	Late 1960s to 1970s landings < the 25th percentile of values 1947-2010 and > the 75th percentile in 1986-1995, 2005 and 2007-2010. Landings peaked in 1990 but declined to level above long term means and have increased since 2000.	See above	+
4 Commercial CPUE	Mandatory logs 2004-2010	Unstandardized CPUE increased a small amount over the 2004-2010 period with 2010 1.1x the 7 year median.	Unstandardized CPUE is affected by environmental conditions which have not been accounted for	N
5 Commercial CPUE	Voluntary logs 1985-2009	CPUE declined in the early 1990s followed by increasing CPUE. The present levels are similar to those of the period of higher landings in the early 1990s.	Not uniformly distributed Numbers variable and declining over time Unstandardized	+
7 Median size in catch	Port Samples	The median sizes in LFA 27 show a continual increase of the period because of ongoing increases in the Minimum Legal Size (MLS).	Timing and number of the port samples vary	+

Table 3.10, continued. Summary table of Fishery Performance indicators for LFA 27. Categorized as positive ("+") if mean of overall index for last 3 years is >=120% of the median for 1999-2010; neutral ("N") if mean of last 3 years is 80-120% of median for 1999-2010 and negative if mean of last 3 years is < 80% of median for 1999-2010.

Characteristic	**Indicator/ Source**	**Conclusions**	**Caveats**	**Overall status**
9 Coefficient of variation	Port Samples	The CV is observed to decrease in LFA 27 with a smaller CV indicating less variability and thus the catch more concentrated on a smaller range of sizes.	Timing and number of the port samples vary	**N**
10 Effort TH	Mandatory logs 2004-2010	Estimates of total trap hauls shows increases in the estimated trap hauls since 2004 peaking in 2008 and declining.	Short time series Incomplete records in early years Influenced by weather, economics and catch rates Increased effort may be response to increasing abundance	**N**
11 Effort Days Fished	Self reporting and mandatory logs 2001-2010	Total days fished and mean days fished per fishermen were stable or without trend. Days/fishermen has remained relatively constant with on average fisherman active 70% of the days available.	Short time series Incomplete records in early years Influenced by weather, economics and catch rates Increased effort may be response to increasing abundance	**N**

Table 3.11. Summary table of Fishery Performance indicators for LFA 28-32. Categorized as positive ("+") if mean of overall index for last 3 years is >=120% of the median for 1999-2010; neutral ("N") if mean of last 3 years is 80-120% of median for 1999-2010 and negative if mean of last 3 years is < 80% of median for 1999-2010.

Characteristic	Indicator/ Source	Conclusions	Caveats	Overall status
Historical Landings	Landings from sales slips, self reporting logs, mandatory logs	LFA 28-31 had a large decline during the 1890s to early 1900s followed by smaller peaks in the early 1930s and mid 1950s. An all time low occurred in the late 1970s. As in LFA 27, landings increased during the 1980s and peaked in 1990, though the increase was much smaller than in LFA 27. Landings rose sharply between 2004 and 2009, with 2009 landings 4.5 times those of 2004 and almost matching the all time highs of 1895.	Landing levels are a function of abundance, level of fishing effort (trap hauls and Soak Over Days-SOD), timing of effort, fishing strategy, catchability (environmental, gear efficiency, density, and lobster movements), and the distribution of animals and effort. Changes in any of these can affect landing levels. Thus, changes in landings are not a direct reflection of changes in abundance.	**+**
Recent Landings	Landings from sales slips, self reporting logs, mandatory logs	During 1970s and early 1980s landing < the 25th percentile of values 1947-2010 and > the then 75th percentile 2005-2010. Individual LFAs vary with LFA 29-31(a+b) showing unprecedented increase since approximately 2005. LFA 32 had a smaller increase with the increases greatest in the eastern half adjacent to LFA 31b.	See above	**+**
Commercial CPUE	Mandatory logs 2004-2010	In all LFAs, the unstandardized CPUE increased a small amount over the 2004-2009 period with 2010 down slightly.	Unstandardized CPUE is affected by environmental conditions which have not been accounted for	**N**
Commercial CPUE	Voluntary logs 1985-2009	In all the LFAs, a decline in CPUE is observed in the early 1990s followed by increased CPUE. The rate of increase was greatest in LFA 31a and 31b. In LFA 31a, 31b and 32 the present CPUE levels are the highest in the series.	Not uniformly distributed Numbers variable and declining over time	**+**
Median size in catch	Port Samples	The median sizes in LFA 29 showed decrease 1999-2005 but increased 2007-2009, 31a, and 31b showed similar decreases but data lacking for most recent years.	Timing and number of the port samples vary	**N**
Coefficient of variation	Port Samples	The CV in LFA 29 decreased 1999-2004 and has remained constant The CV in LFA 31a, and 31b showed smaller and more variable decreases, but data lacking for most recent years. No trend is observed in LFA 32. A smaller CV indicating less variability and thus the catch more concentrated on a smaller range of sizes.	Timing and number of the port samples vary	**N**

Table 3.11, continued. Summary table of Fishery Performance indicators for LFA 28-32. Categorized as positive ("+") if mean of overall index for last 3 years is >=120% of the median for 1999-2010; neutral ("N") if mean of last 3 years is 80-120% of median for 1999-2010 and negative if mean of last 3 years is < 80% of median for 1999-2010.

Characteristic	Indicator/ Source	Conclusions	Caveats	Overall status
Effort TH	Mandatory logs 2004-2010	The data shows increases in the estimated trap hauls since 2004 with many LFAs peaking in 2008 and declining	Short time series Incomplete records in early years Influenced by weather, economics and catch rates Increased effort likely response to increasing abundance	**N**
Effort Days Fished	Self reporting and mandatory logs 2001-2010	Total days fished and mean days fished per fishermen are either stable or without trend (LFA 28, 30, 32) or have shown an increasing trend (LFA 29, 31a, 31b) Those which have increased are also the LFAs which at the start of the data set had where fishing a lower proportion of the available days and are also those LFAs which have experienced large increases in landings. Overall the average proportion of potential days fished increased from 66% in 2002 to 81% in 2007-08 and declined slightly to 78% in 2010.	Short time series Incomplete records in early years Influenced by weather, economics and catch rates Increased effort likely response to increasing abundance	**N**

Table 3.12. Summary table of Fishery Performance indicators for LFA 33. Categorized as positive ("+") if mean of overall index for last 3 years is >=120% of the median for 1999-2010; neutral ("N") if mean of last 3 years is 80-120% of median for 1999-2010 and negative if mean of last 3 years is < 80% of median for 1999-2010.

Characteristic	Indicator/ Source	Conclusions	Caveats	Overall status
Historical Landings	Landings from sales slips, self reporting logs, mandatory logs	LFA 32-33 (Fig. 3.3c) exhibited a large decline during the 1890s and early 1900s and was followed by low landings through the 1930s and 1940s. A small increase is evident in the early 1950s but by the 1960s is in decline reaching all time lows in the late 1970s. As observed in other lobster areas landings increased during the 1980s and in LFA 32-33 peaked in 1987. Though landings declined in the early 1990s they remained above levels observed since 1920s, and since 2004 have increased. The 2009 landings are at 1.4x the peak of 1987 and 16x the record low of 1978, though still below the all time highs of the 1890s.	Landing levels are a function of abundance, level of fishing effort (trap hauls and Soak Over Days-SOD), timing of effort, fishing strategy, catchability (environmental, gear efficiency, density, and lobster movements), and the distribution of animals and effort. Changes in any of these can affect landing levels. Thus, changes in landings are not a direct reflection of changes in abundance.	+
Recent Landings	Landings from sales slips, self reporting logs, mandatory logs	During 1970s and early 1980s landing < the 25th percentile of values 1947-2010 and > the then 75th percentile 1997-98 to 2009-10. The last 3 years are the highest in the series.	See above	+
Commercial CPUE	Mandatory logs 2004-2010	Consistent differences exist between East and West LFA 33 with CPUE lower in the East. The unstandardized CPUE increased a small amount over the time series.	Short time series Unstandardized CPUE is affected by environmental conditions which have not been accounted for	N
Commercial CPUE	Voluntary logs 1985-2009	CPUE declined in the early 1990s followed by increased CPUE. In LFA 33, the present levels are similar to those of the period of higher landings in the early 1990s.	Not uniformly distributed Numbers variable and declining over time Unstandardized	+
Median size in catch	Port Samples	The median sizes in LFA 33 fluctuate without trend.	Timing and number of the port samples vary	N
Coefficient of variation	Port Samples	No consistent trend is observed in LFA 33.	Timing and number of the port samples vary	N
Effort TH	Mandatory logs 2004-2010	The data shows increases in the estimated trap hauls since 2004 with many LFAs peaking in 2007-08 and either remaining near that level.	Short time series Incomplete records in early years Influenced by weather, economics and catch rates Increased effort may be response to increasing abundance	N
Effort Days Fished	Self reporting and mandatory logs 2001-2010	Total days fished and mean days fished per fishermen have shown a small up to 2007-08.	Short time series Incomplete records in early years Influenced by weather, economics and catch rates Increased effort may be response to increasing abundance	N

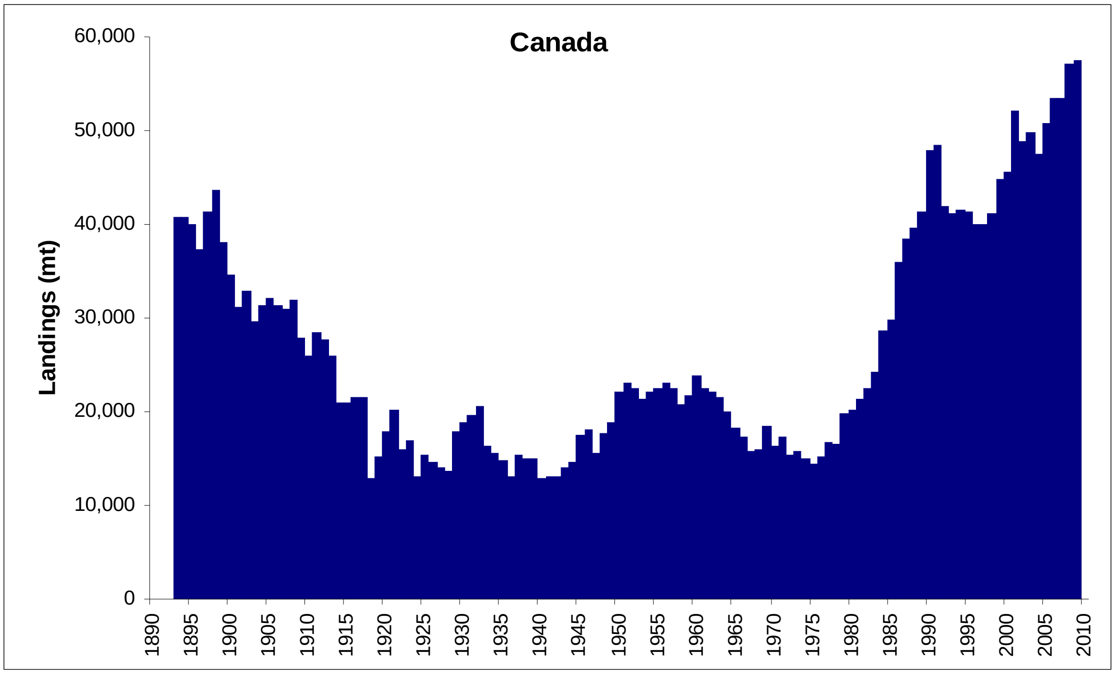


Figure 3.1. Canadian lobster landings 1892-2009 (2009 preliminary).

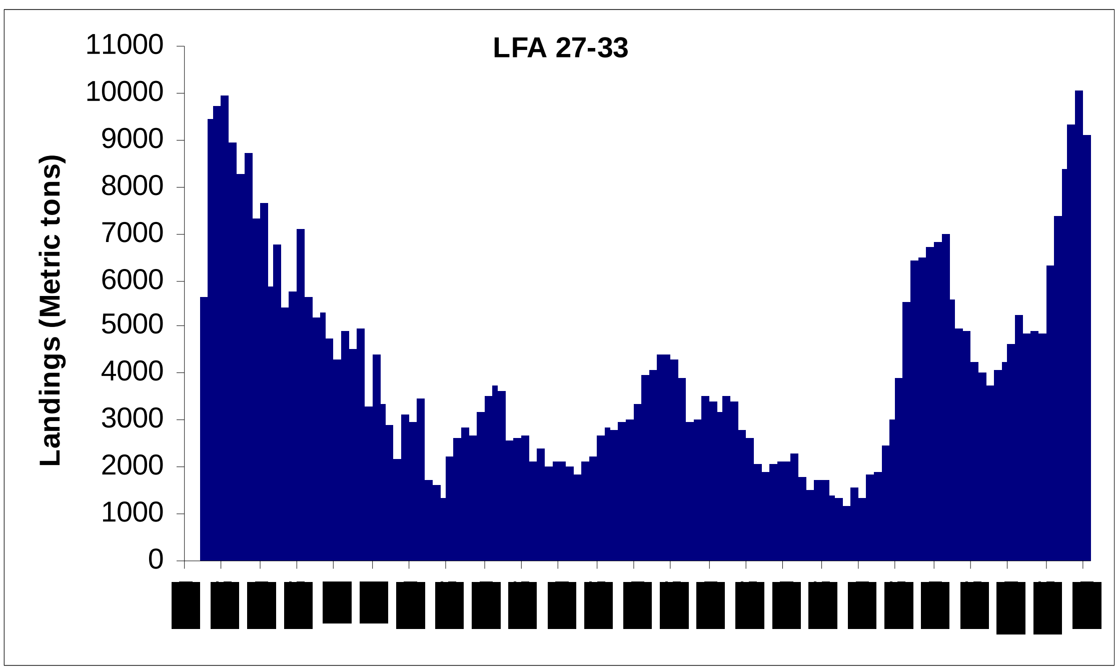


Figure 3.2. LFA 27-33 lobster landings 1892-2010 (2010 preliminary).

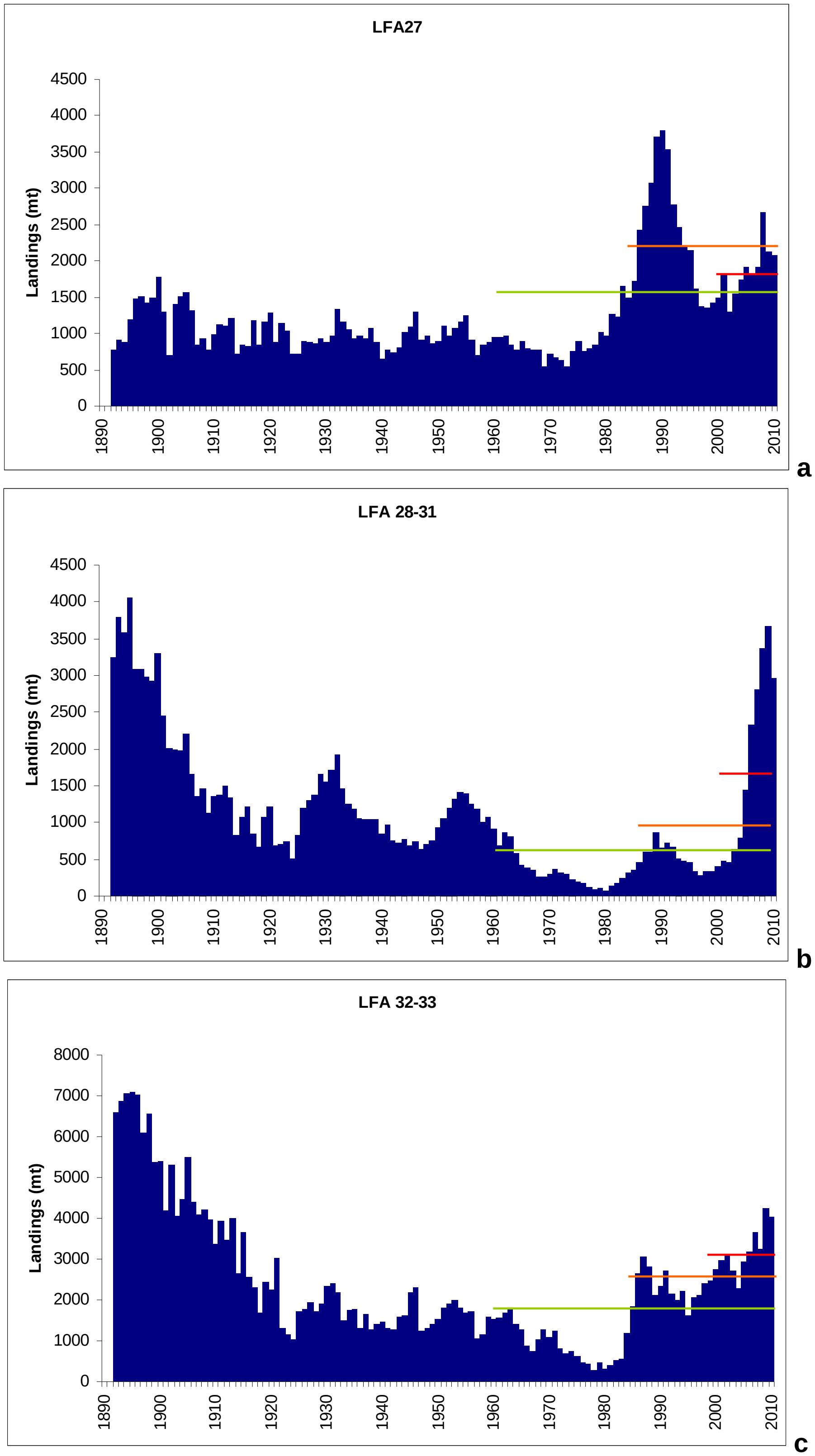


Figure 3.3. Lobster landings 1892-2010 (2010 preliminary) a) LFA 27, b) LFA 28-31, c) LFA 32-33; showing mean landings for recent 10yr____, 25yr____ and 50yr____.

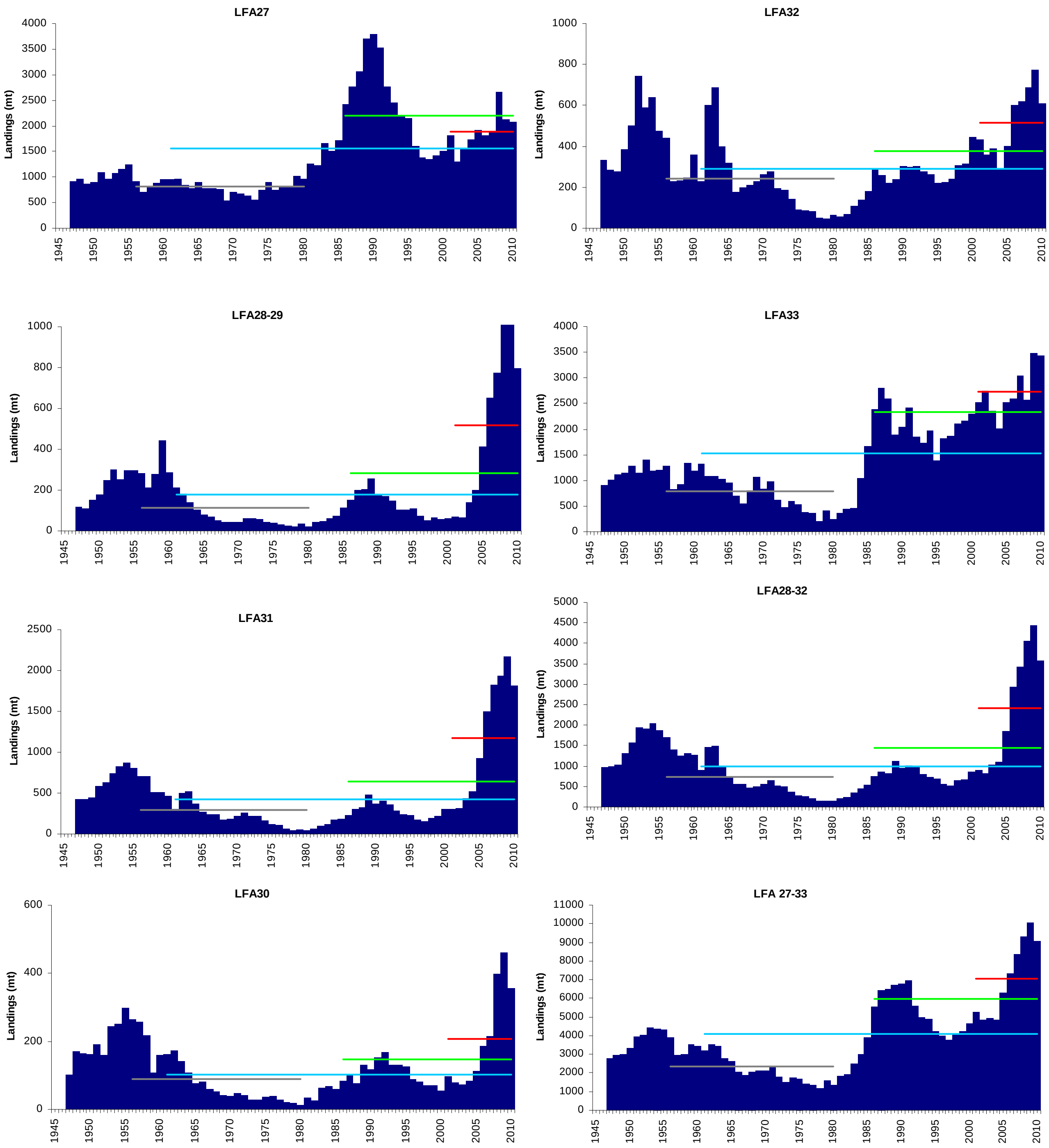


Figure 3.4. Lobster landings 1947-2010 (2010 preliminary) showing mean landings for last 10yr____, 25yr ____, 50y ____, and 1955-1979____.

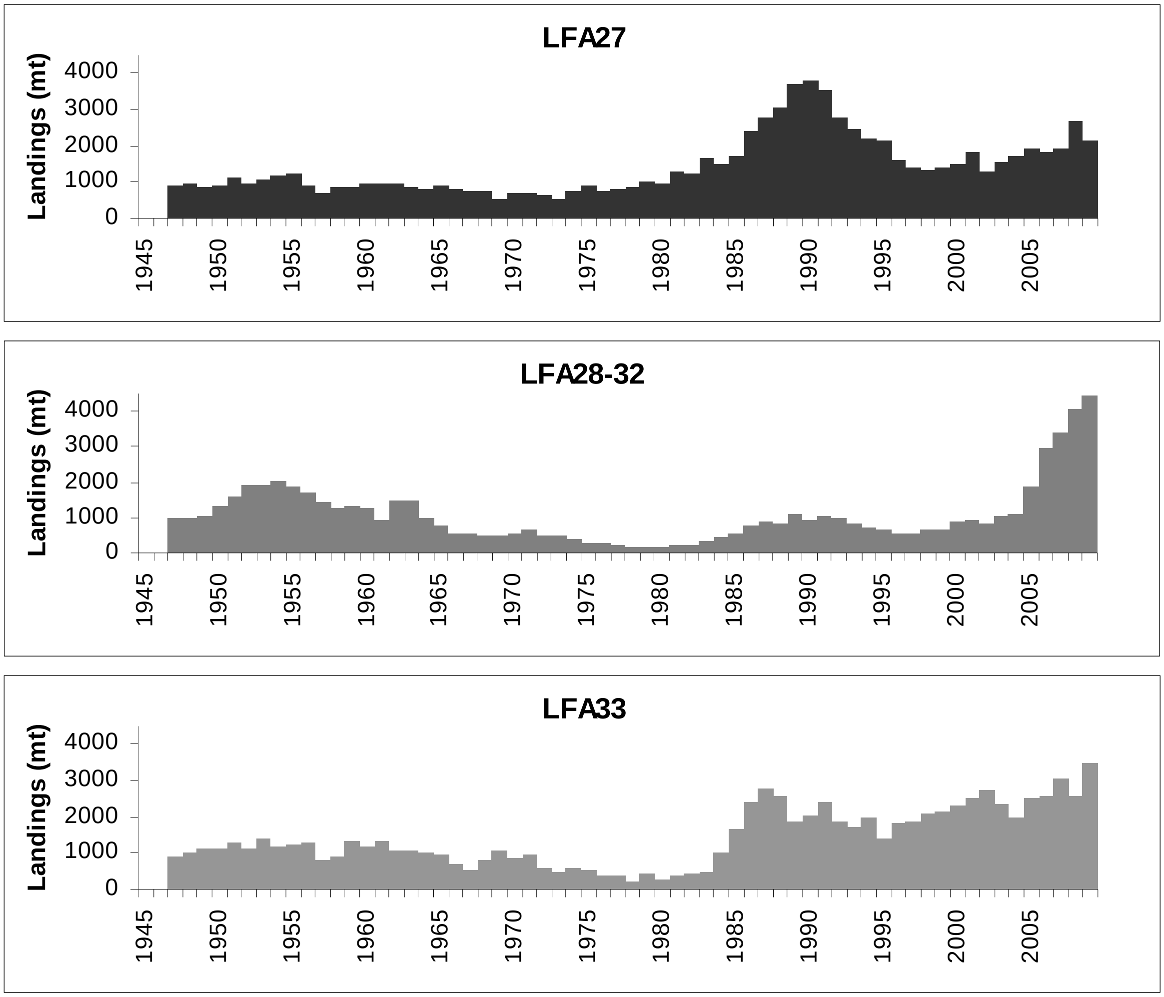


Figure 3.5. Lobster landings 1947-2010 by assessment units LFA 27, LFA 28-32 and LFA 33.

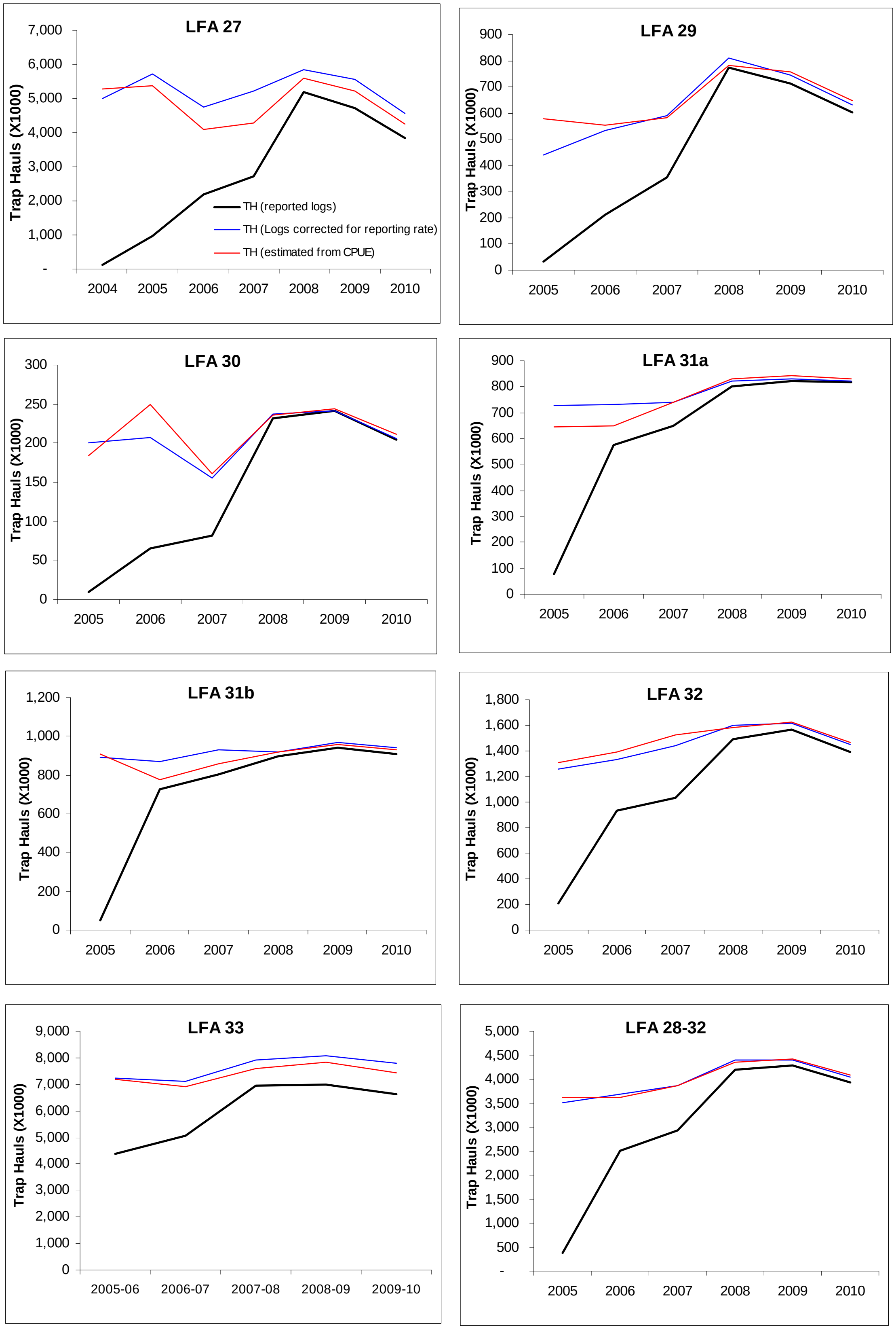


Figure 3.6. Total Trap Hauls (TH) reported in the mandatory logs and estimated total TH based on reported TH corrected for proportion of logs reporting and based on landings/ CPUE from log books.

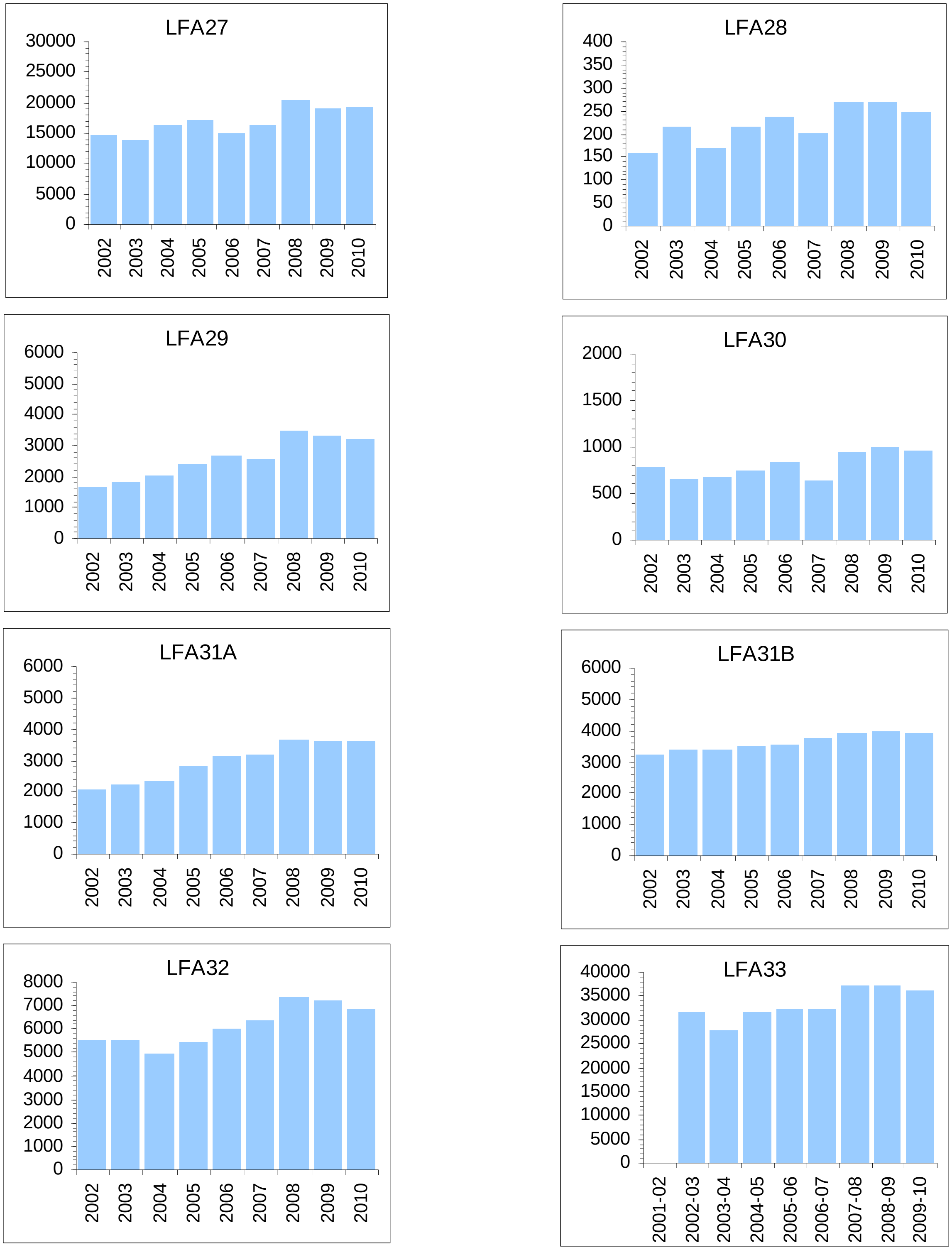


Figure 3.7. Total days fished based on compulsory logs.

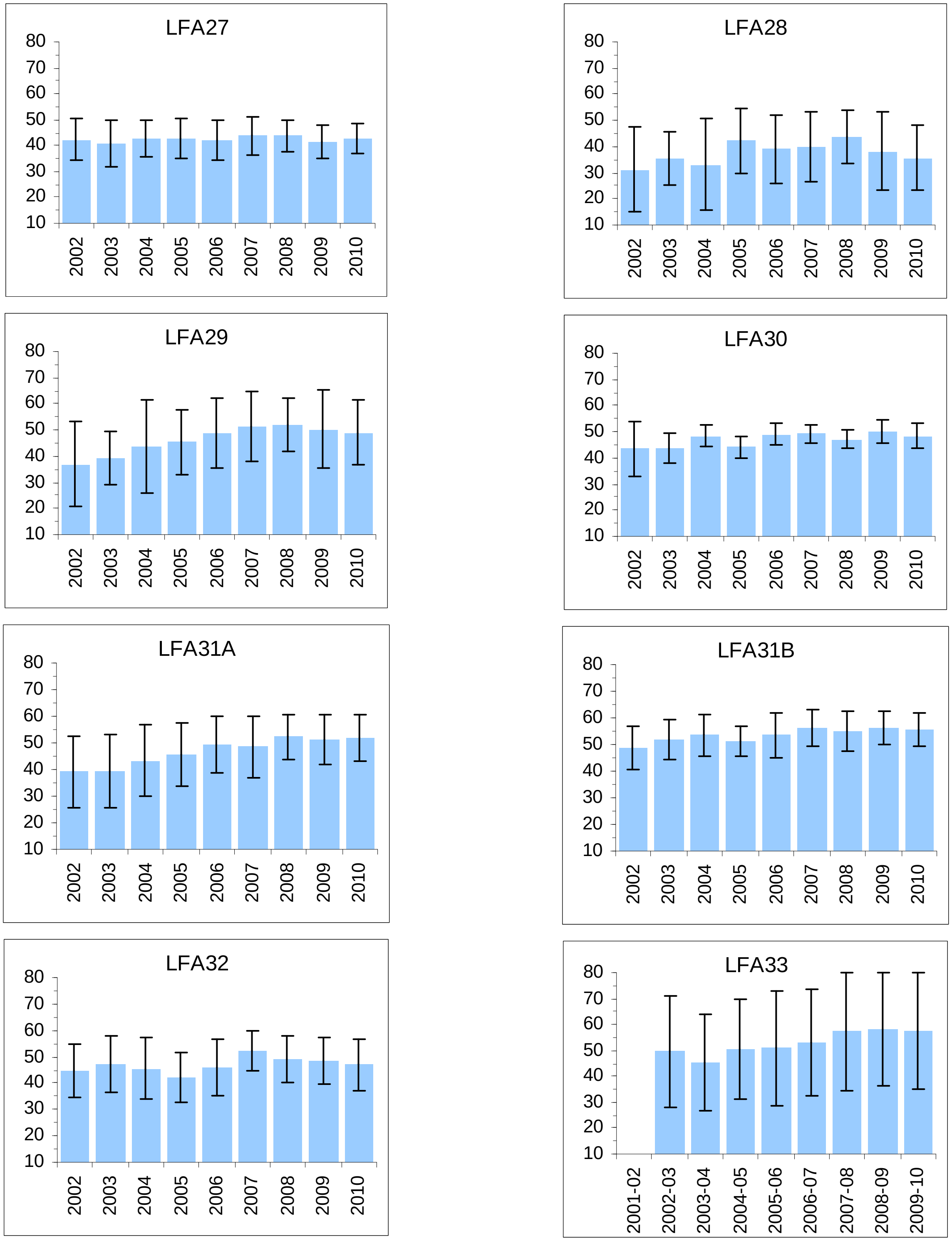


Figure 3.8. Mean and SD number of days fished based on compulsory logs.

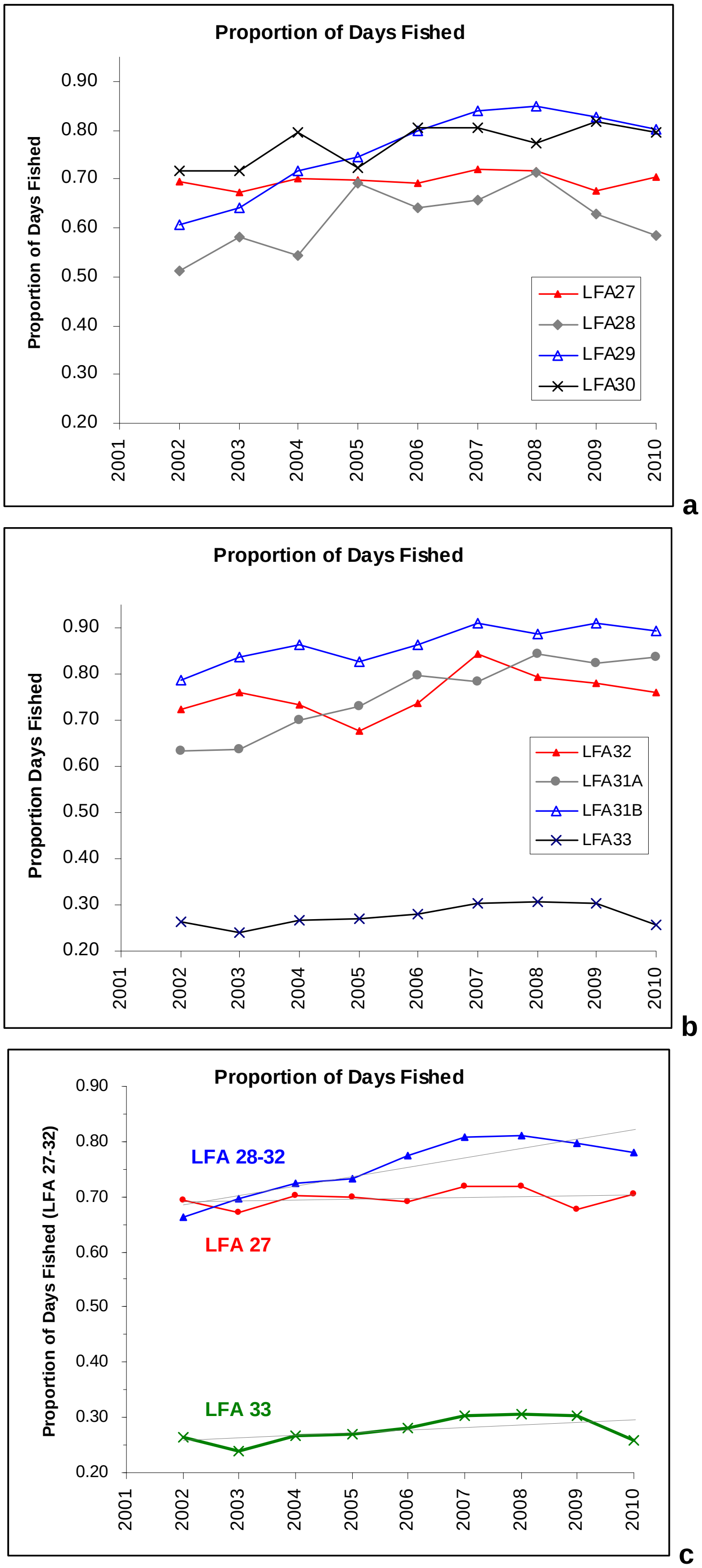
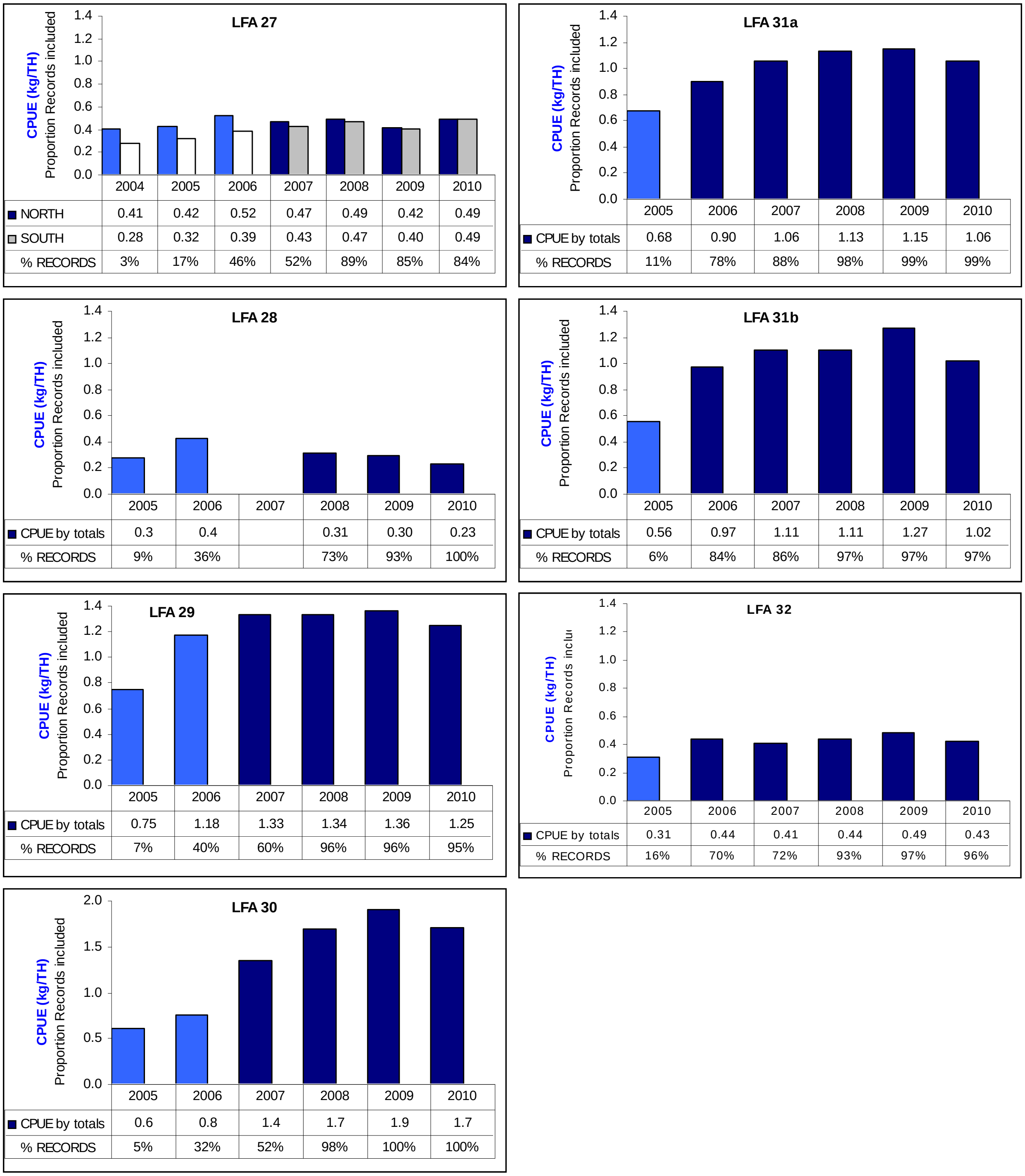


Figure 3.9. Mean proportion of the potential days fished. a) LFA 27, 28, 29, 30; b) LFA 31a, 31b, 32, 33; c) LFA 27, LFA 28-32, LFA 33.



LFA 27

	2004	2005	2006	2007	2008	2009	2010
NORTH	0.41	0.42	0.52	0.47	0.49	0.42	0.49
SOUTH	0.28	0.32	0.39	0.43	0.47	0.40	0.49
% RECORDS	3%	17%	46%	52%	89%	85%	84%

LFA 31a

	2005	2006	2007	2008	2009	2010
CPUE by totals	0.68	0.90	1.06	1.13	1.15	1.06
% RECORDS	11%	78%	88%	98%	99%	99%

LFA 28

	2005	2006	2007	2008	2009	2010
CPUE by totals	0.3	0.4		0.31	0.30	0.23
% RECORDS	9%	36%		73%	93%	100%

LFA 31b

	2005	2006	2007	2008	2009	2010
CPUE by totals	0.56	0.97	1.11	1.11	1.27	1.02
% RECORDS	6%	84%	86%	97%	97%	97%

LFA 29

	2005	2006	2007	2008	2009	2010
CPUE by totals	0.75	1.18	1.33	1.34	1.36	1.25
% RECORDS	7%	40%	60%	96%	96%	95%

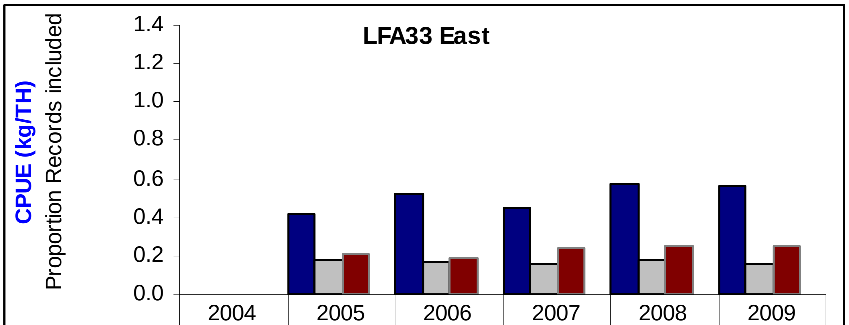
LFA 32

	2005	2006	2007	2008	2009	2010
CPUE by totals	0.31	0.44	0.41	0.44	0.49	0.43
% RECORDS	16%	70%	72%	93%	97%	96%

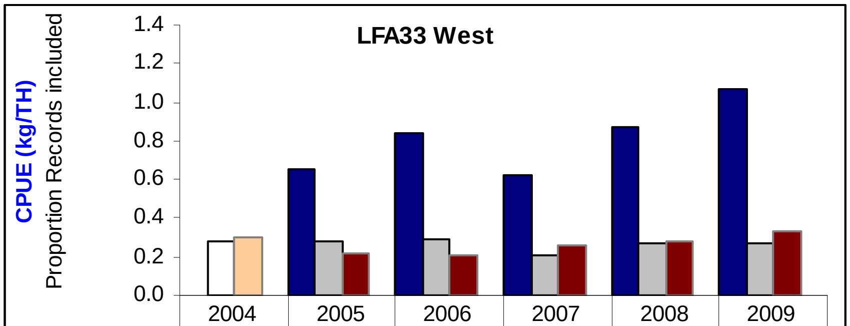
LFA 30

	2005	2006	2007	2008	2009	2010
CPUE by totals	0.6	0.8	1.4	1.7	1.9	1.7
% RECORDS	5%	32%	52%	98%	100%	100%

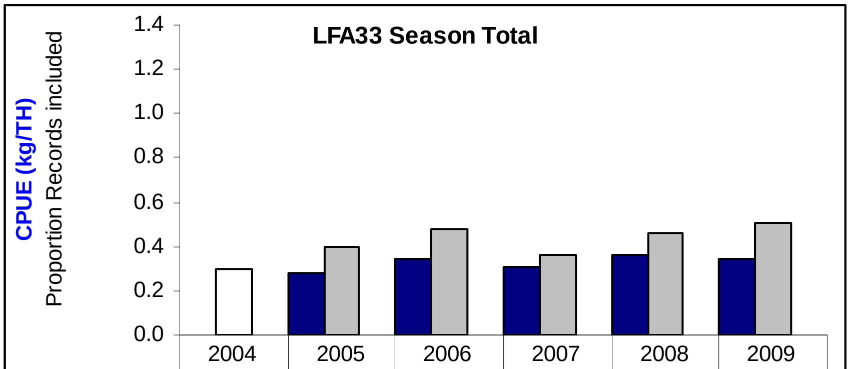
Figure 3.10. LFA 27-32 Catch per unit effort (Kg/Trap Haul) from mandatory commercial logs by season and LFA 27 subunit, 2005 to 2010. Bars with the lighter shade of blue represent data with less than 50% of the records.



	2004	2005	2006	2007	2008	2009
fall		0.42	0.52	0.45	0.58	0.57
winter		0.17	0.17	0.15	0.18	0.16
spring		0.21	0.19	0.24	0.25	0.26
% RECORDS	0.5%	61%	71%	88%	87%	85%



	2004	2005	2006	2007	2008	2009
fall		0.65	0.84	0.62	0.88	1.06
winter	0.28	0.28	0.29	0.20	0.27	0.27
spring	0.30	0.22	0.21	0.26	0.28	0.33
% RECORDS	0.5%	61%	71%	88%	87%	85%



	2004	2005	2006	2007	2008	2009
East		0.28	0.34	0.31	0.37	0.35
West	0.29	0.40	0.48	0.36	0.46	0.50
% RECORDS	0.5%	61%	71%	88%	87%	85%

Figure 3.11. LFA 33 Catch per unit effort (Kg/Trap Haul) from mandatory commercial logs by season, period, and LFA 33 subunit, from 2005-06 to 2009-10. Bars with no colour represent data with less than 50% of the records.

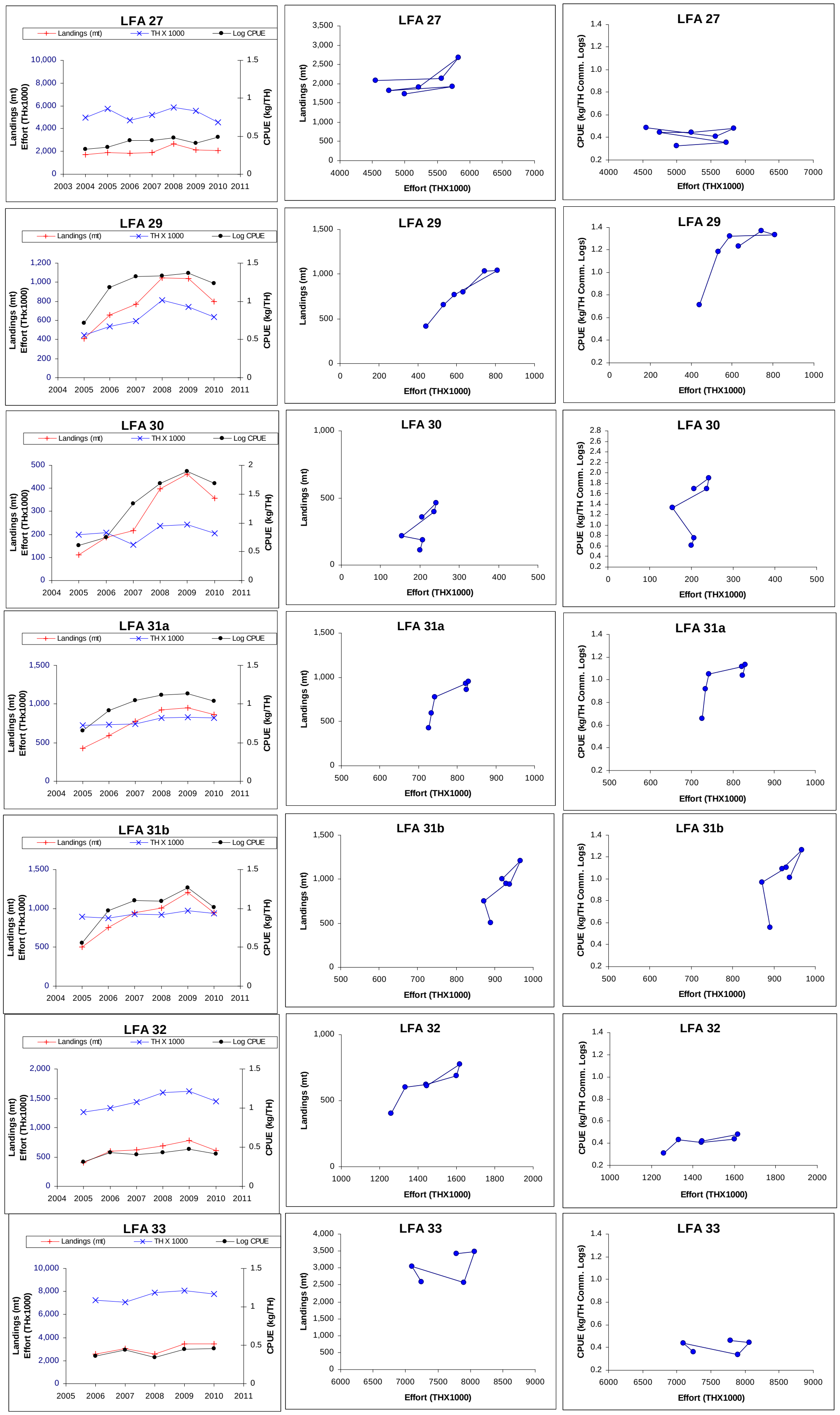


Figure 3.12. Lobster landings, effort and CPUE from compulsory logs.

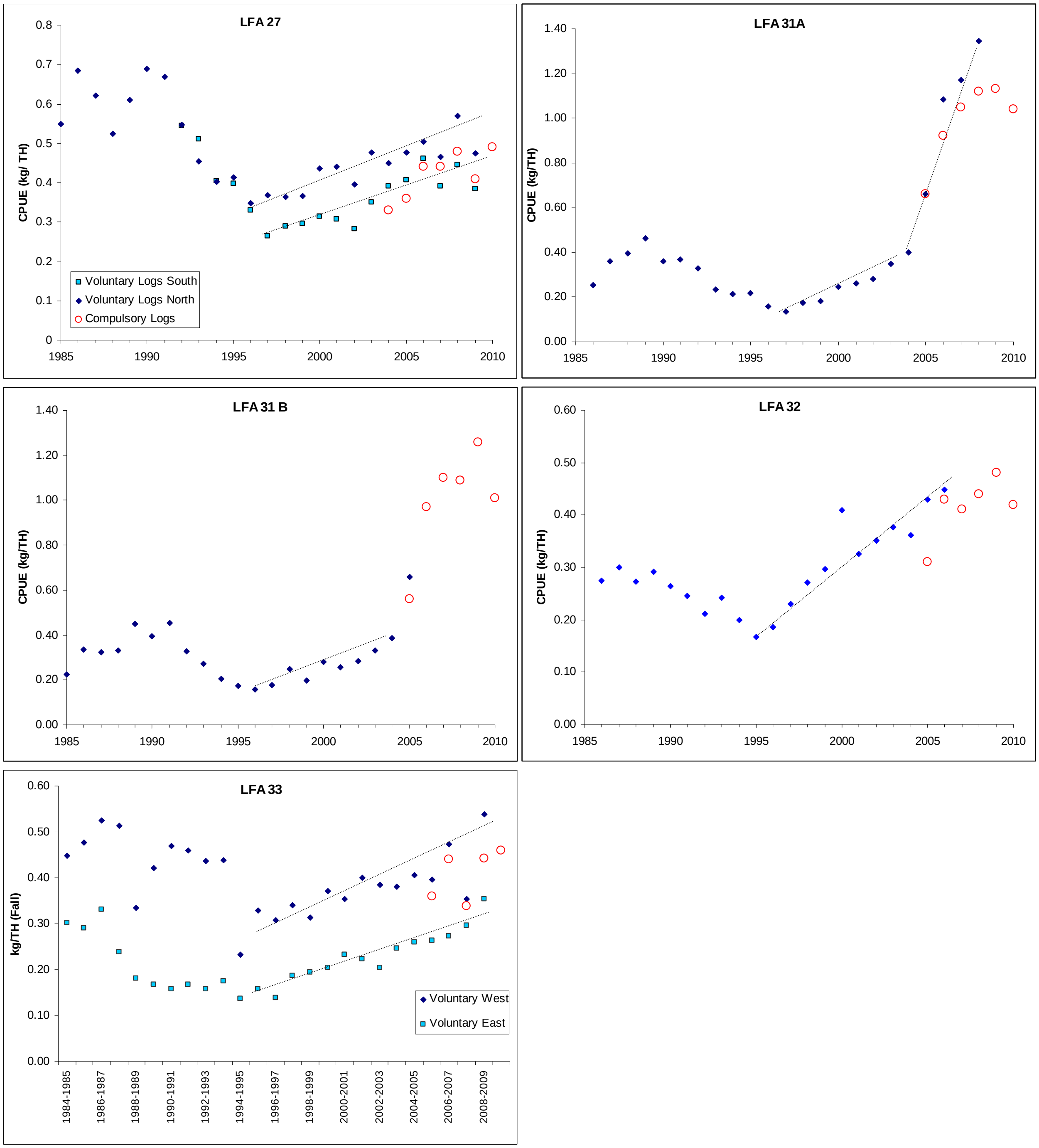


Figure 3.13. Mean CPUE (kg/TH) from voluntary logs and compulsory logs for LFA 27 (north and south), 31a, 31b, 32 and 33 (East and West).

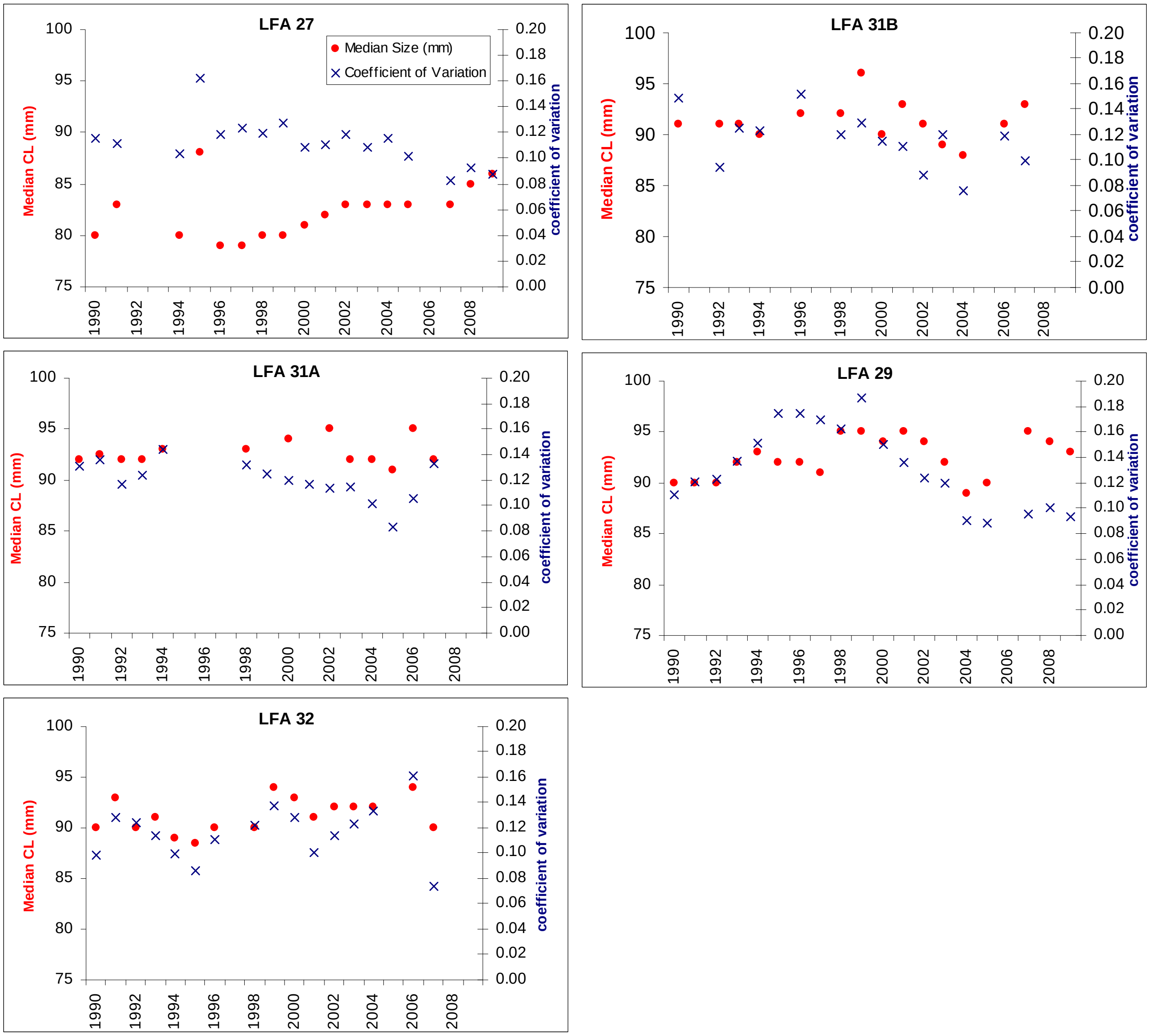


Figure 3.14. Median sizes and CV from port samples LFA 27, 29, 30, 31a, 31b and 32.

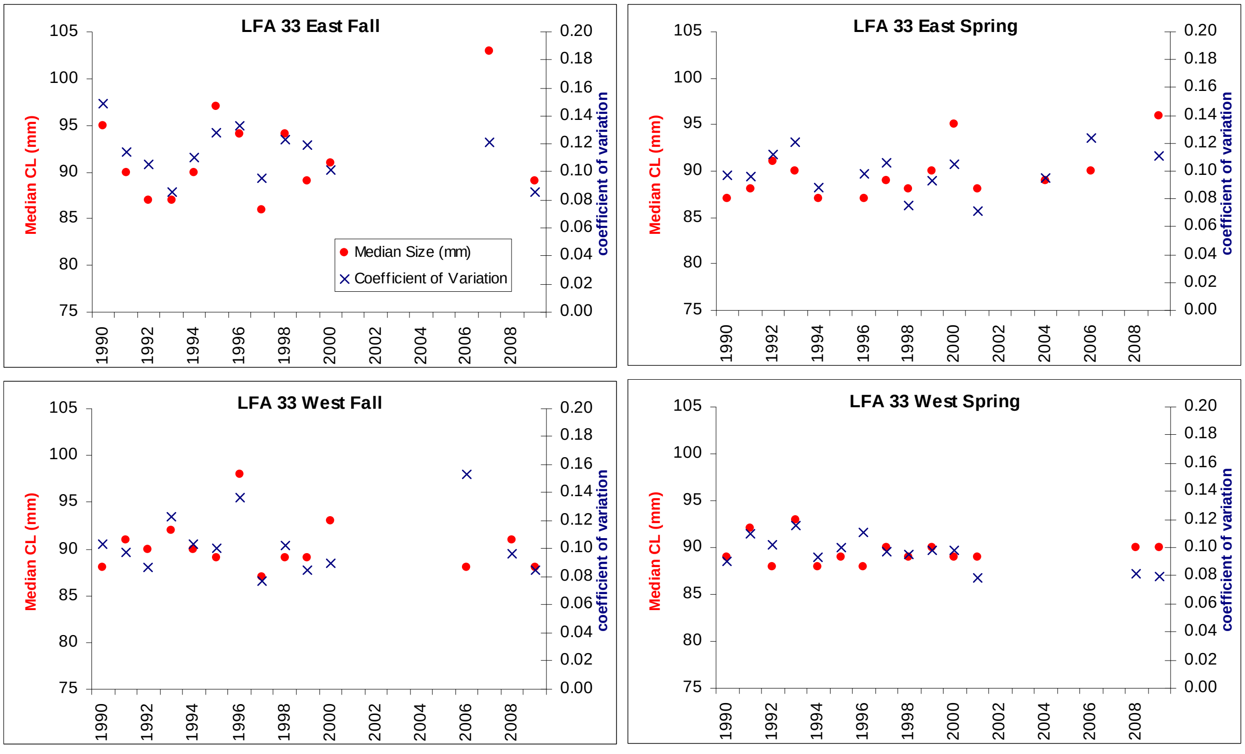


Figure 3.15. Median sizes and CV from port samples LFA 33 East and West, fall and spring.

4. STANDARDIZED CPUE FROM FSRS TRAPS: SUBLEGAL AND LEGAL SIZES

4.1. METHODS

In the framework research document (Tremblay et al. 2011), statistical models applied to LFA 27 were described, including Generalized Linear Models (GLMs) with CPUE as a function of week of season, year and fisherman, and a mixed effects model with fisherman as a random effect.

In the current document, the mixed effects model is used for LFA 27 as described in 27 (Tremblay et al. 2011). This model has year and week as fixed effects, and the vessel (=fisherman) effect as a random factor. This model was developed to deal with geographic differences within LFA 27, and to overcome the challenge of changing vessels over time within LFA 27.

For LFAs 28, 29, 30, 31a, 31b, and 32, the application of a single model was thought to be inappropriate because of the different start dates of the fishing season. LFA 31b and LFA 32, for example, start on April 19^{th}; LFA 30 does not start until May 20^{th}. We explored a mixed effect model for LFA 33 and for LFA 29 and 31a combined (the latter two LFAs have similar seasons), but the diagnostic plots indicated a poor fit for the models selected.

As a result, we applied GLM models to each individual LFA as described in Tremblay et al. (2011). CPUE was modeled as a function of week, year, and vessel with the latter as a fixed effect. In each case, we used a gamma distribution with a log link. Because we used a log link, CPUE values of 0 had to be excluded. The numbers of data points removed after aggregating the data by week are shown in Table 4.1.

4.2. RESULTS AND DISCUSSION

4.2.1. <u>LFA 27</u>

<u>Sublegals</u>

Box plots for the raw CPUE of sublegals in FSRS traps by fisherman per year for each subunit are shown in Fig. 4.1. In all subunits, CPUE was higher in the second half of the time series than the first half.

For the mixed effect model analysis, we updated the diagnostic plots shown in Figures 5.15-5.17 of Tremblay et al. (2011) with the additional year (2010) and they were nearly identical. As such, the reader is referred to the discussion of these plots in Tremblay et al. (2011). Overall, the fit is satisfactory although there are some outliers.

The predicted values for the number of sublegals per trap haul in FSRS traps in LFA 27 subunits are shown in Fig. 4.2. These represent an update of Figure 5.18 in Tremblay et al. (2011). The predicted values show trends similar to the raw CPUE data (Fig. 4.1). The values indicate an upturn in 2010 relative to 2009 in 3 of 4 subunits. These same subunits are at or near the highest values since 1999. The north central subunit (SD 4) represents an anomaly in that the sublegal index has dropped for the second year in a row; the reasons for this decline are not clear.

A sublegal index for all of LFA 27 (Fig. 4.3) was created by weighting the estimates in Fig. 4.2 by the landings in each subunit. Overall in LFA 27, the sublegal index has increased substantially since the early part of the time series. The median for the last 3 years (2.65) is 1.4 times the median for 1999-2007 (=1.82).

The above weighting is at least partly related to the amount of effort in the different subunits. As an alternative method of weighting, the length of rocky shoreline from Hudon (1994) was used (Fig. 4.4). This weighting is more analogous to the approach used to scale up the results of a survey. The resultant figure gives a very similar trend to the weighting by landings. Values of the index were slightly lower (average of 7%) compared to the index based on weighting by landings.

A large part of the increase in the sublegal index in LFA 27 is the result of the increase in MLS. Lobsters that were previously captured and retained are now left in the water for an additional year. The increase in LFA 27-south may be related to the increase in recruitment observed in LFAs 29, 31 and 30 (see below). Changes in the sublegal index may result from both real changes in abundance and changes in availability due to environmental conditions.

Legal Sizes

Box plots for the raw CPUE of legal sizes in FSRS traps by fisherman per year for each subunit are shown in Figure 4.5. They indicate considerable variability with some downward trend in recent years in several subunits.

As for the sublegal model, we updated the model diagnostic plots for legal sizes in LFA 27 shown in Figures 5.11-5.13 of Tremblay et al. (2011) with the additional year (2010). Again, these new plots were nearly identical to those for 1999-2009.

The predicted values for the number of legal sizes per trap haul in FSRS traps in LFA 27 subunits are shown in Figure 4.6. They trend in a manner similar to the raw CPUE (Fig. 4.5). The values for LFA 27-south are the highest in the time period, while the values for LFA 27-northcentral and central have fluctuated without trend the last 4 years. The value for LFA 27-north has declined and is the second lowest in the time series.

An index for legal sizes for all of LFA 27 (Fig. 4.7) was created by weighting the estimates in Figure 4.6 by the landings in each subunit. The index fluctuated without trend over the time period. The median for the last 3 years (1.3) is 1.1 times the median for 1999-2007 (=1.22) and the value for 2010 was the fourth highest for the time series. As for the sublegals, an index weighted by length of rocky shoreline (Fig. 4.8) was very similar to that based on weighting by landings. Values of this index averaged 5% lower than the values from the index based on weighting by landings.

It should be noted that the CPUE index of legal sizes from FSRS traps is expressed in units of numbers per trap, and thus does not account for any changes in the weight of the average lobster in the retained catch. Thus, even though this index did not trend upwards over the period (Fig. 4.8), we know the catch rate in terms of weight must have increased. The median size of lobsters in the landed catch increased from 80 mm CL in 1999 to 86 mm CL in 2009 (Table 3.9). Based on a carapace length-weight relationship from the southern Gulf of St. Lawrence (Comeau et al. 2007), an 80 mm CL lobster in LFA 27 weighs approximately 411 g, while an 86 mm CL lobster weights approximately 508 g or 24% more. Even if CPUE in terms of number per trap haul was constant in LFA 27 from 1999 to 2009, we would expect an increase on the order of 24% in the weight per trap haul. This explains why the catch rate in weight from logs (Fig. 3.13) trended upwards in LFA 27, while the CPUE index in terms of numbers did not.

The sublegal index for LFA 27 as a whole (Fig. 4.3 and Fig. 4.4) is not a good predictor of the legal index 1 to 2 years in advance. In fact, the correlation is stronger when the index for legal sizes is plotted against the sublegal index for the same year (Fig. 4.9). A similar finding is reported in Tremblay et al. (2009). This may be related to (i) the increase in MLS increasing the sublegal index independent of an increase in recruitment (ii) the fact that the sublegal index includes several size groups that molt to legal sizes over several years and (iii) environmental influences affecting both indices in the same direction in some years.

<u>Summary</u>

The main conclusions for LFA 27 sublegal and legal abundance based on the FSRS recruitment trap data are in Table 4.2.

4.2.2. <u>LFAs 29-32</u>

<u>Sublegals</u>

Box plots for the raw CPUE of sublegals in FSRS traps by fisherman per year for LFAs 28-32 LFA are shown in Figure 4.10. There were just two participants in LFA 28 so their results are not displayed here. Figure 4.10 indicates strong increases in sublegal CPUE beginning in 2003 for LFAs 29, 30, and 31, with a small increase in the same year in LFA 32.

GLM models were applied to each of LFA 29, 30, 31A, 31B and 32. The model diagnostics are shown in Appendix 2. The model fits appear to be satisfactory for the most part. There are deviations from normality for the LFA 30 model and some “banding” is some of the residual plots (e.g. LFA 32).

The model predicted values of sublegals for LFA 29-32 from the GLM models are shown in Figure 4.11. The index is estimated for week=9. The values show trends very similar to the box plots in Figure 4.10.

A sublegal CPUE index for LFAs 29-32 as a whole (Fig. 4.12) based on weighting the values in Figure 4.11 by landings is shown in Figure 4.12. This overall index indicates a rapid rise to a peak in 2006-2007 with lower values in the last 3 years. An index created by weighting by length of rocky shoreline (Fig. 4.13) shows a similar trend but not as strong a peak. This is because LFA 32 with its long shoreline and lower landings receives more weight than in the index based on weighting by landings. Using either weighting, the mean CPUE of the last 3 years is above the median for 2000-2007.

<u>Legal Sizes</u>

Box plots for the raw CPUE of legal sizes in FSRS traps by fisherman per year for LFAs 29-32 LFA are shown in Figure 4.14. Again there was a strong increase in CPUE, particularly in LFAs 29 and 30 but also in LFAs 31A and 31B. The increase in CPUE of legal sizes lagged the increase in sublegal CPUE by 1-2 years. Recent years have shown a decline.

The diagnostic plots for the GLM models for LFAs 29, 30, 31A, 31B and 32 are shown in Appendix 2. Again, the model fits appear reasonable, although the same banding patterns as noted with the sublegals are apparent in the residual plots for LFA 32.

The model predicted values for legal sizes for LFA 29-32 from the GLM models are shown in Figure 4.15. Again, the predicted values show trends similar to the box plots (Fig. 4.11). In recent years, the values have remained high (LFA 29) or have dropped off somewhat (LFA 31A).

The CPUE index for legal sizes in LFAs 29-32 as a whole from weighting by landings (Fig. 4.16) indicates a rise to a peak in 2008-09 and a reduction in 2010. The CPUE index from weighting by length of rocky shoreline (Fig. 4.17) rises to 2006 and then is steady until 2010 when CPUE dropped. Regardless of which weighting is used, the mean for 2008-2010 is still well above the median for 2000-2007.

<u>Summary</u>

The main conclusions for LFA 29-32 sublegal and legal abundance based on the FSRS recruitment trap data are in Table 4.3.

4.2.3. <u>LFA 33</u>

<u>Sublegals</u>

Box plots for the raw CPUE of sublegals in FSRS traps by fisherman per year for LFA 33 (East and West) are shown in Figure 4.18. The mean annual CPUEs by fisherman together with an annual mean are depicted in Figure 4.19. Both figures illustrate the higher CPUE in the west than in the east. The raw data do not suggest any strong trends although there were more high outliers in the data for the west in the last 5 years.

The diagnostic plots for the GLM models for LFA 33 East and LFA 33 East are shown in Appendix 2. Only the fit for the sublegals in LFA 33 West appears satisfactory; the significant banding patterns for both models for LFA 33 East and for legal sizes for LFA 33 West, suggest alternative models need exploration.

The model predicted values for sublegal CPUE for LFA 33 from the GLM models are shown in Figure 4.20. They show some of the same features as the raw data, with a generally upward trend in the last 7-8 years.

The CPUE index for sublegals in LFA 33 as a whole weighted by landings indicates an upward trend since 2002 (Fig. 4.21). An index based on weighting the values in Figure 4.20 by length of rocky shoreline shows a very similar trend (Fig. 4.22) with somewhat lower values (average of 18%). Depending on which overall index is used, the mean for the last 3 yr (2.81 for weighting by landings, 2.39 for weighting by shoreline length) is 1.15-1.20 times the median for 1999-2007 (2.43 and 1.99).

In a companion research document, a temperature-corrected index also showed a substantial increase in the abundance of sublegals from 2000 to 2007 (Allard et al. 2012).

<u>Legal Sizes</u>

Box plots for the raw CPUE of legal sizes in FSRS traps by fisherman per year for LFA 33 (East and West) are shown in Figure 4.23. The mean annual legal CPUEs by fisherman together with an annual mean are depicted in Figure 4.24. Again, no strong trends are evident over the time period.

The model predicted values for legal sizes for LFA 33 from the GLM models are shown in Figure 4.25. They indicate relatively high values for the east in recent years, and intermediate values for the west. The CPUE index for legal sizes in LFA 33 as a whole weighted by landings (Fig. 4.26) indicates relatively little change over the time period. The CPUE index weighted by length of rocky shoreline (Fig. 4.27) is again lower (average 6%) and indicates a very slight upward trend over the period. The median for the last 3 years was close to the median for 1999-2010 (1.04 versus 1.04 for index weighted by landings, 1.00 versus 0.93 for the index weighted by length of rocky shoreline).

Summary

The main conclusions for LFA 33 sublegal and legal abundance based on the FSRS recruitment trap data are in Table 4.4.

Table 4.1. Number of records excluded (CPUE = 0) after aggregating the data by year, vessel (fisherman), and week of season for the GLM analysis on each LFA.

	LFA27	LFA29	LFA30	LFA31A	LFA31B	LFA32	LFA33
Total number of records after aggregation	2830	506	434	624	997	1518	6084
Number removed for sublegal analysis	15	0	0	12	17	63	92
Number removed for legal analysis	82	16	2	30	17	82	980

Table 4.2. Summary table of Abundance indicators from FSRS traps; LFA 27. Categorized as positive ("+") if median of overall index for last 3 years is >=120% of the median for 1999-2010; neutral ("N") if median of last 3 years is 80-120% of median for 1999-2010 and negative if median of last 3 years is < 80% of median for 1999-2010.

Characteristic	Indicator/Source	Conclusions	Caveats	Overall status
Abundance of sublegals	Sublegal CPUE (no per trap haul) - LFA 27 FSRS recruitment traps	**Overall increased abundance of sublegals; currently above median for 1999-2007.** • LFA 27 total: upward trend over the last decade in FSRS sublegal CPUE (raw data and model) • CPUE index (weighting by landings): Median (2.65) and mean (2.69) for last 3 yr > median for 1999-2007 (=1.82)	• Presumed to be largely the result of MLS increase with possible exception of LFA 27 south • CPUE is affected by environmental conditions which have not been accounted for	**+**
Abundance of commercial sizes-	Legal CPUE (no per trap haul) - LFA 27 FSRS recruitment traps	**No trend in abundance in legal sizes in LFA 27overall; differences exist among subunits. Overall median currently above median for 1999-2007.** • LFA 27 total: fluctuated without trend over the last decade (raw data and model) • CPUE index (weighting by landings): Median (1.30) & Mean (1.31) for last 3 yr > median for 1999-2007 (=1.22) • LFA 27 subunits: LFA 27 south has increased; remainder of LFA 27 fluctuating without trend or declining	• CPUE is affected by environmental conditions which have not been accounted for	**N**

Table 4.3. Summary table of Abundance indicators from FSRS traps; LFAs 28-32. Categorized as positive ("+") if median of overall index for last 3 years is >=120% of the median for 2000-2010; neutral ("N") if median of last 3 years is 80-120% of median for 2000-2010 and negative if median of last 3 years is < 80% of median for 2000-2010.

Characteristic	Indicator/Source	Conclusions	Caveats	Overall status
Abundance of sublegals in LFAs 28-32	Prerecruit CPUE (no per trap haul) - LFA 28-32 FSRS recruitment traps	**Overall abundance of sublegals increased over the decade and although abundance has recently declined, it is still high relative to 2000-2002. There are some differences among LFAs.** • LFA 29-32 total: substantial upward trend 2003-2007; declines 2008-2010 • CPUE index (weighting by landings): Median (2.27) & Mean (2.19) for last 3 yr > median for 2000-2007 (=1.83) • CPUE index (weighting by rocky shoreline length): • Median (1.78) and Mean (1.79) for last 3 yr > median for 2000-2007 (=1.69) • LFAs 29, 30 and 31A saw larger increases in recruits than LFA 31B; small increase apparent in LFA 32	• CPUE is affected by environmental conditions which have not been accounted for • LFA 28 had too few participants to display results (n-=2)	**N**

Abundance of commercial sizes in LFAs 28-32	Legal CPUE (no per trap haul) - LFA 28-32 FSRS recruitment traps	**Current abundance of commercial sizes in LFAs 28-32 relatively high but may have peaked. There are some differences among LFAs.**
		• Overall abundance increased 2004-2009
		• CPUE index (weighting by landings): Median (2.36) & Mean (2.26) for last 3 yr > median for 2000-2007 (=0.77)
		• CPUE index (weighting by rocky shoreline length):
		  • Median (1.62) and Mean (1.60) for last 3 yr > median for 2000-2007 (=0.71)
		  • LFAs 29 and 30 had largest increases in commercial CPUE; LFAs 31A and 31B next; no increase apparent in LFA 32
			• CPUE is affected by environmental conditions which have not been accounted for
			• LFA 28 had too few participants to display results (n=2)
				+

Table 4.4. Summary table of Abundance indicators from FSRS traps; LFA 33. Categorized as positive ("+") if median of overall index for last 3 years is >=120% of the median for 1999-2010; neutral ("N") if median of last 3 years is 80-120% of median for 1999-2010 and negative if median of last 3 years is < 80% of median for 1999-2010.

Characteristic	Indicator/Source	Conclusions	Caveats	Overall status
Abundance of sublegals in LFA 33	Prerecruit CPUE (no per trap haul) - LFA 33 FSRS recruitment traps	**Overall abundance of sublegals has** trended **upwards in LFA 33 as a whole.** • CPUE index: Median (2.80) for last 3 yr > median for 1999-2007 (2.43)	• CPUE is affected by environmental conditions which have not been accounted for • Model fits do not appear as good as for other assessment units.	N
Abundance of commercial sizes in LFA 33	Legal CPUE (no per trap haul) - LFA 28-32 FSRS recruitment traps	**Overall abundance of legal sizes** fluctuated **without trend in LFA 33 as whole.** • Box plots of annual means for FSRS participants show fluctuations without trend • CPUE index median (1.04) for last 3 yr (1.04) ~= median for 1999-2007 (1.01)	• CPUE is affected by environmental conditions which have not been accounted for • The match between FSRS CPUE and commercial CPUE may not be as close as in other assessment units because more of the fishery occurs in deeper water than where FSRS traps are set • Model fits are not as good as for other assessment units	N

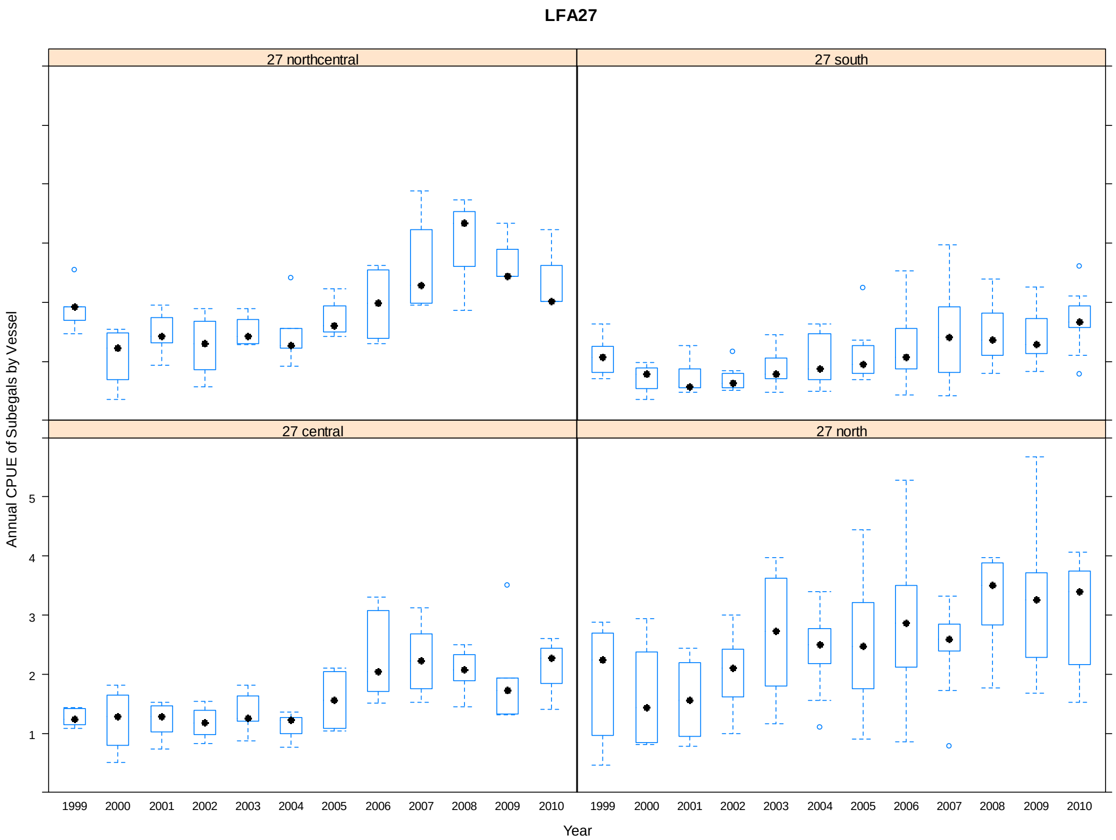


Figure 4.1. Box plots of raw annual CPUE of sublegals for FSRS participants in LFA 27. Annual CPUE = total number of sublegal lobsters/total number of FSRS trap hauls. Dot in box shows median; upper margin of box shows upper quartile (25% of observations greater than this); lower box shows lower quartile. Outer hinges show maxima and minima, excluding outliers. Open circles show outliers, defined as greater than1.5 times the interquartile range (difference between upper and lower quartiles).

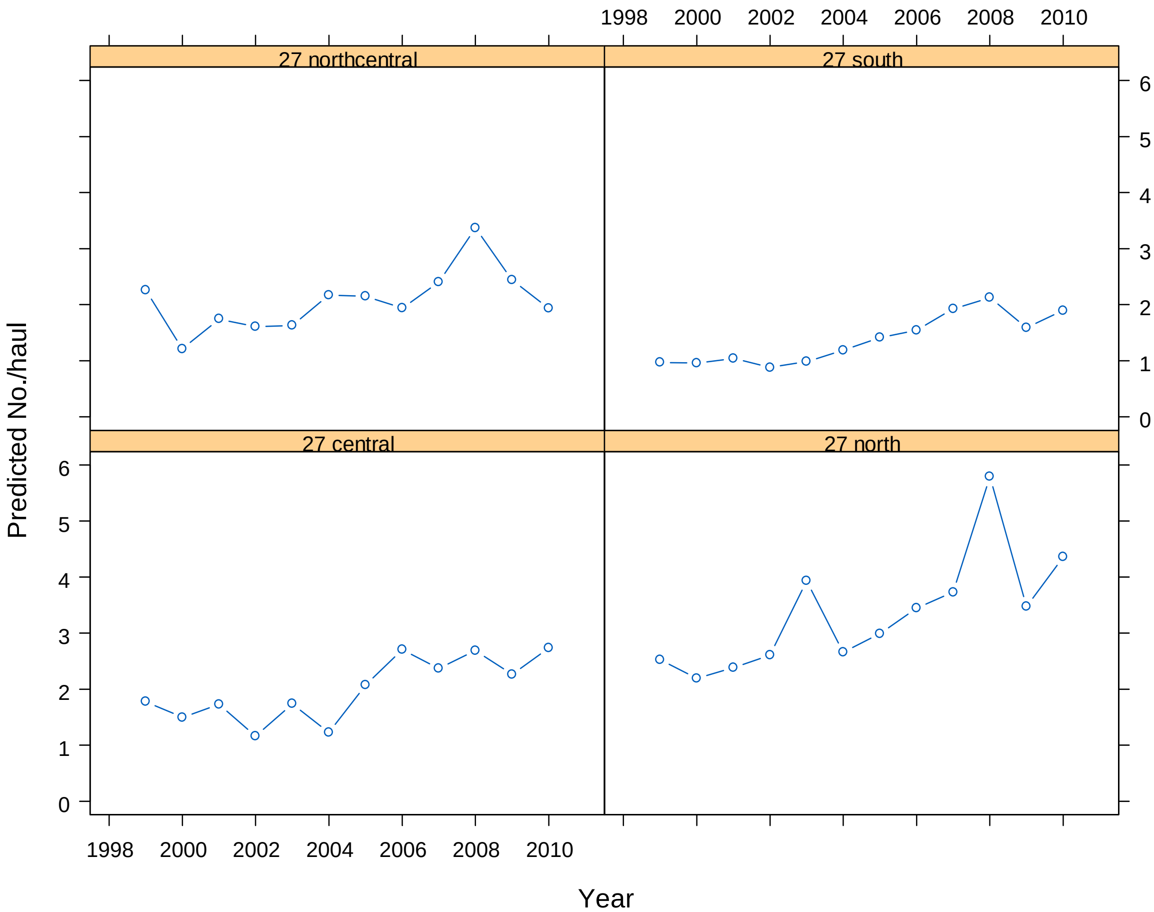


Figure 4.2. Predicted values for sublegal CPUE for LFA 27 subunits from mixed effects model of FSRS recruitment trap data. Values are predicted for week=9.

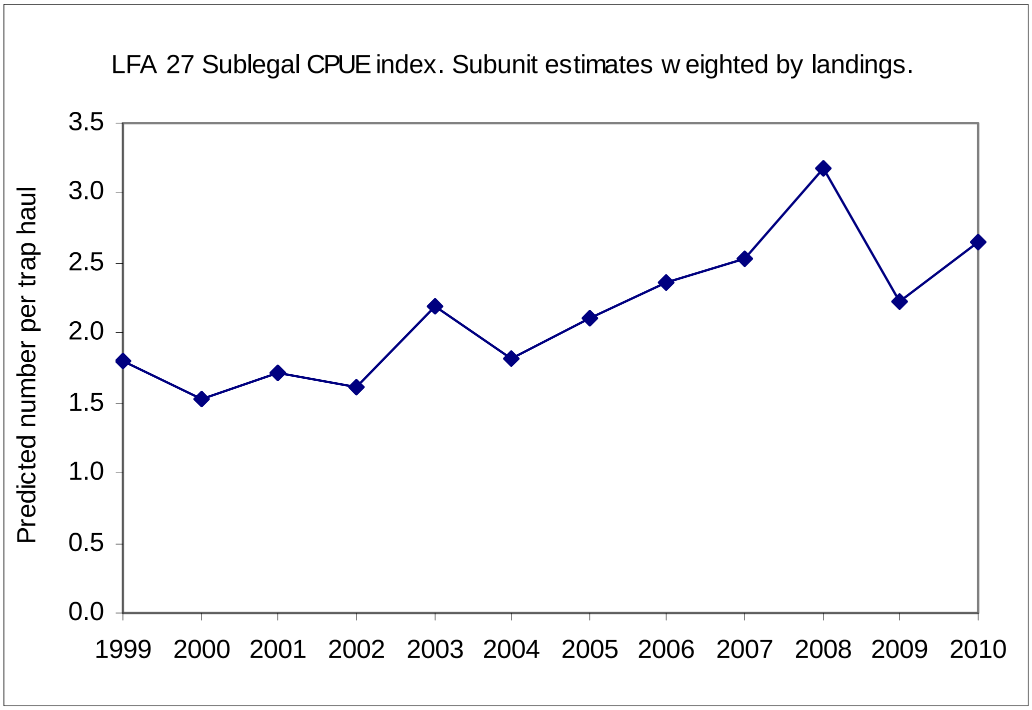


Figure 4.3. CPUE index of sublegal sizes for LFA 27 as a whole created by weighting the estimates in Fig. 4.2 by the landings.

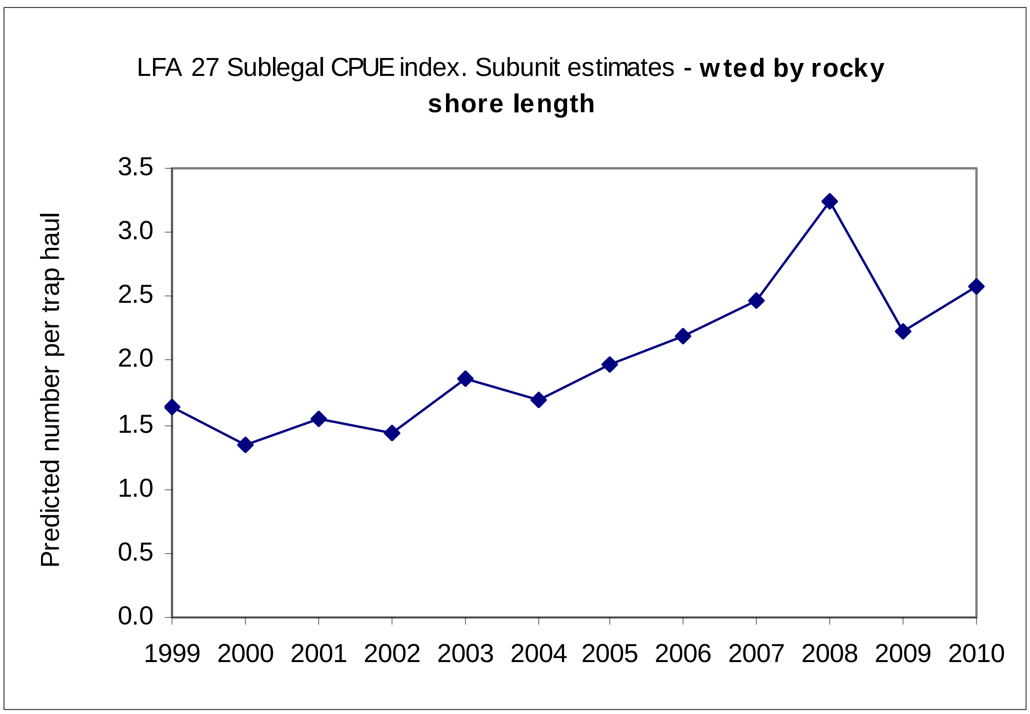


Figure 4.4. CPUE index of sublegal sizes for LFA 27 as a whole created by weighting the estimates in Fig. 4.2 by the length of rocky shoreline as estimated by Hudon (1994).

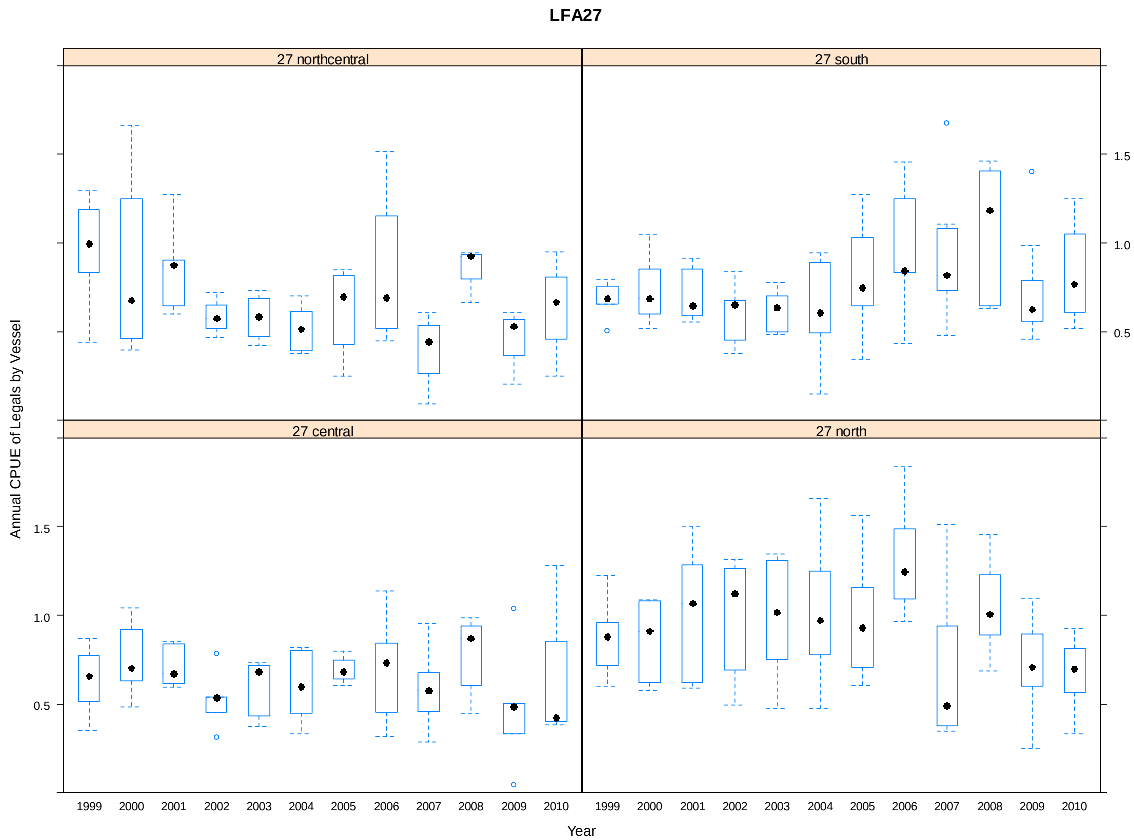


Figure 4.5. Box plots of raw annual CPUE of legal sizes for FSRS participants in LFA 27. Annual CPUE = total number of legal lobsters/total number of FSRS trap hauls. See Fig. 4.1 for description of box plot symbols.

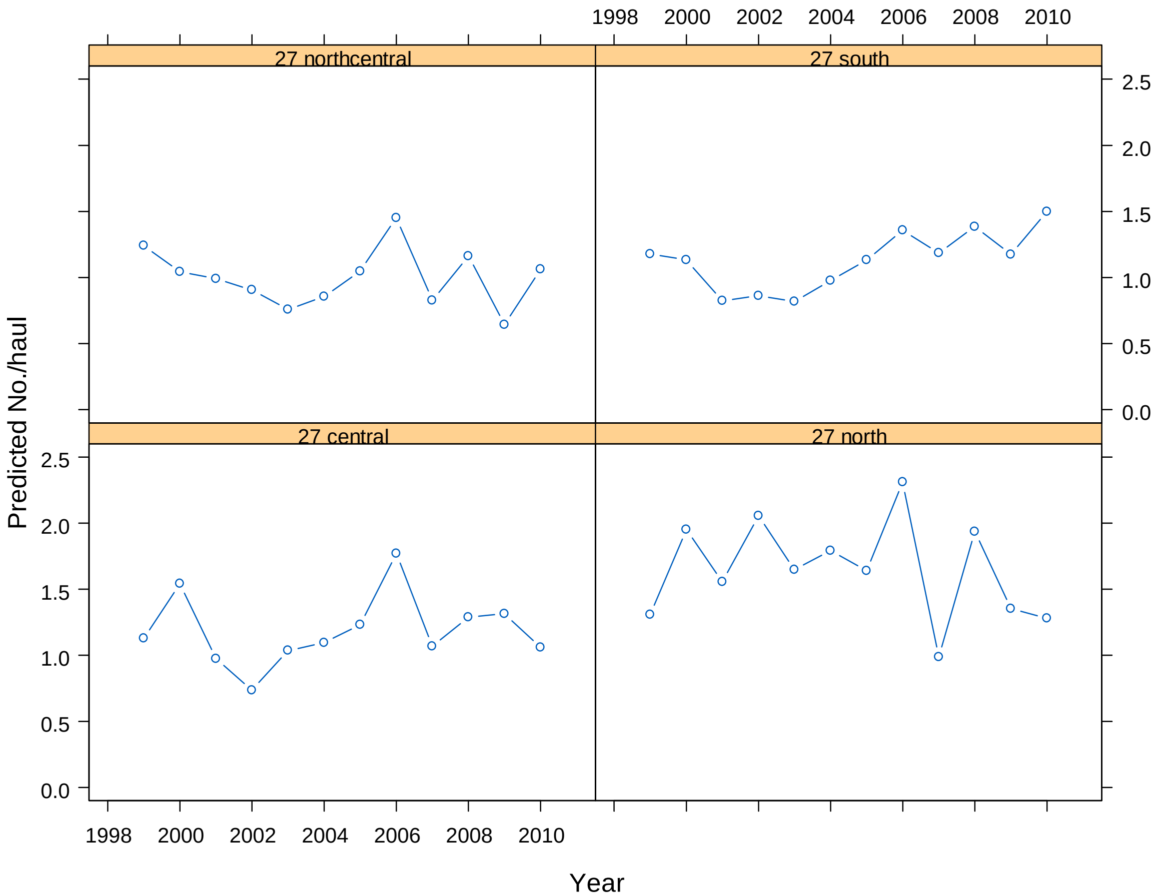


Figure 4.6. Predicted values for legal size CPUE for LFA 27 subunits from mixed effects model of FSRS recruitment trap data. Values are predicted for week=0.

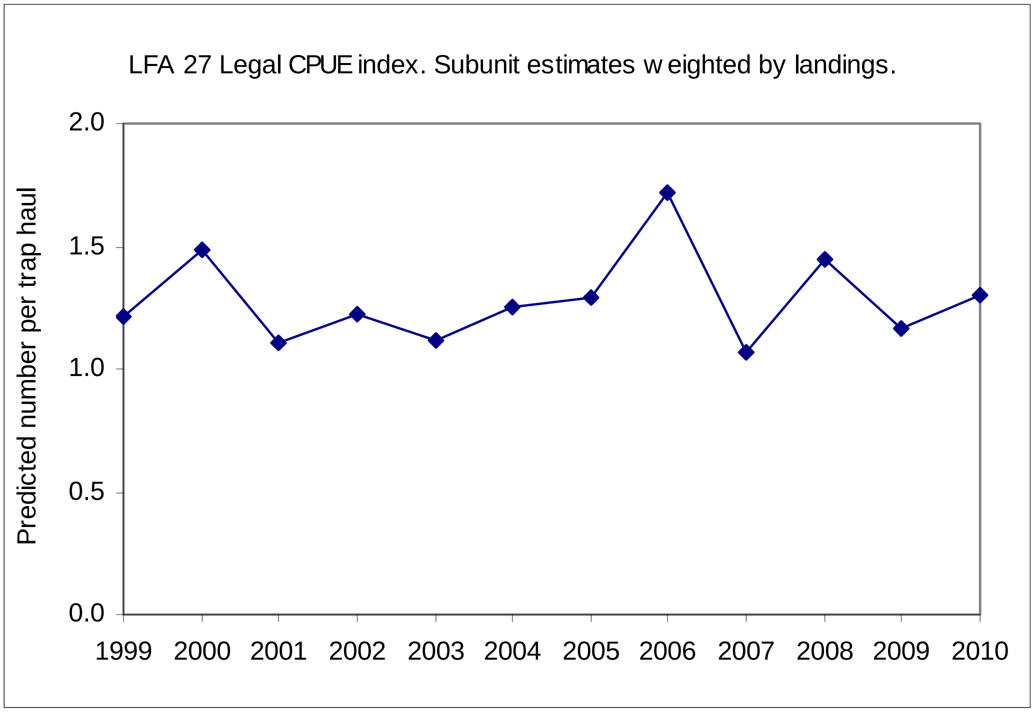


Figure 4.7. CPUE index of legals sizes for LFA 27 as a whole created by weighting the estimates in Fig. 4.6 by the landings.

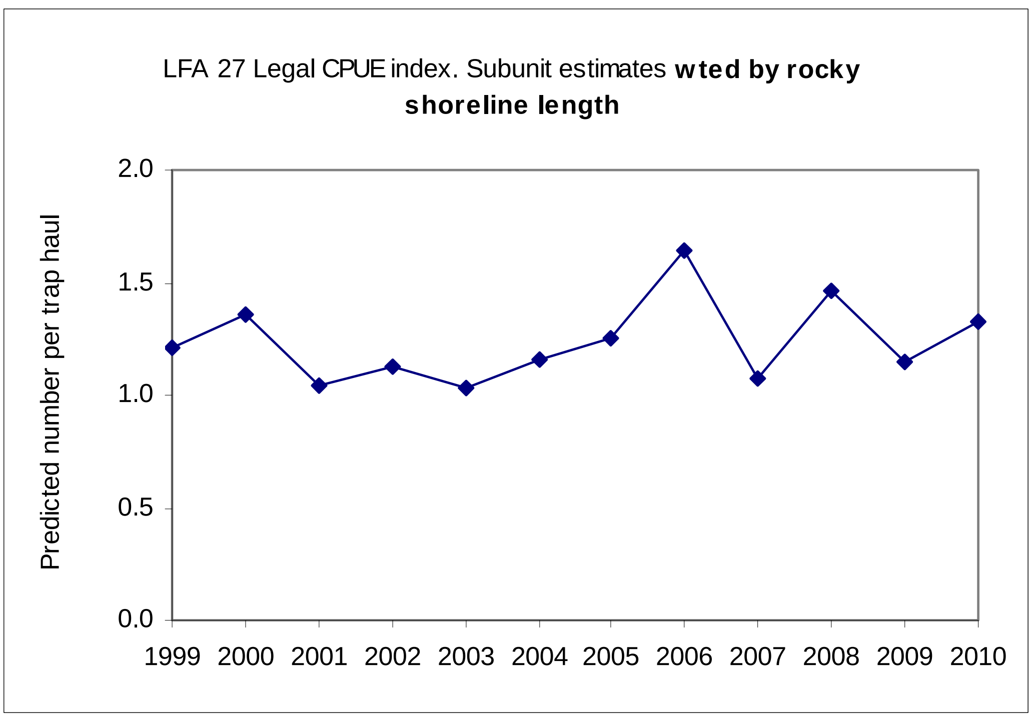
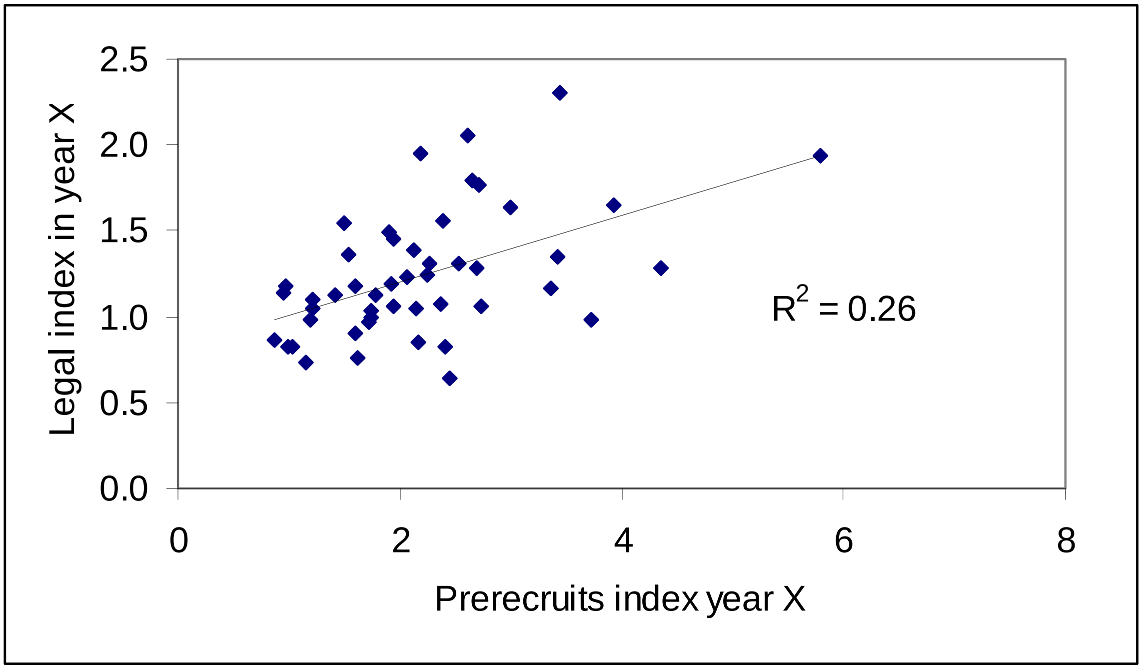


Figure 4.8. CPUE index of legals sizes for LFA 27 as a whole created by weighting the estimates in Fig. 4.6 by the length of rocky shoreline as estimated by Hudon (1994).



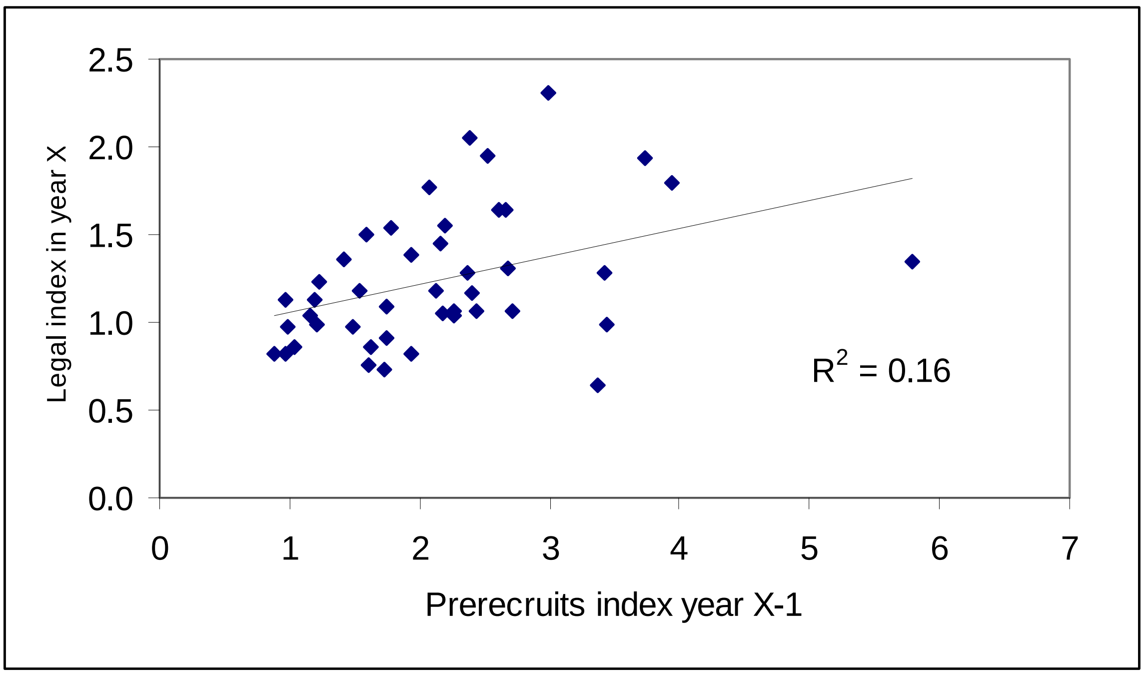


Figure 4.9. LFA 27 model-based index of legal sizes versus model index of sublegals. Upper panel shows the two indices in the same year; lower panel shows the sublegals in year x-1 versus the legals in year x.

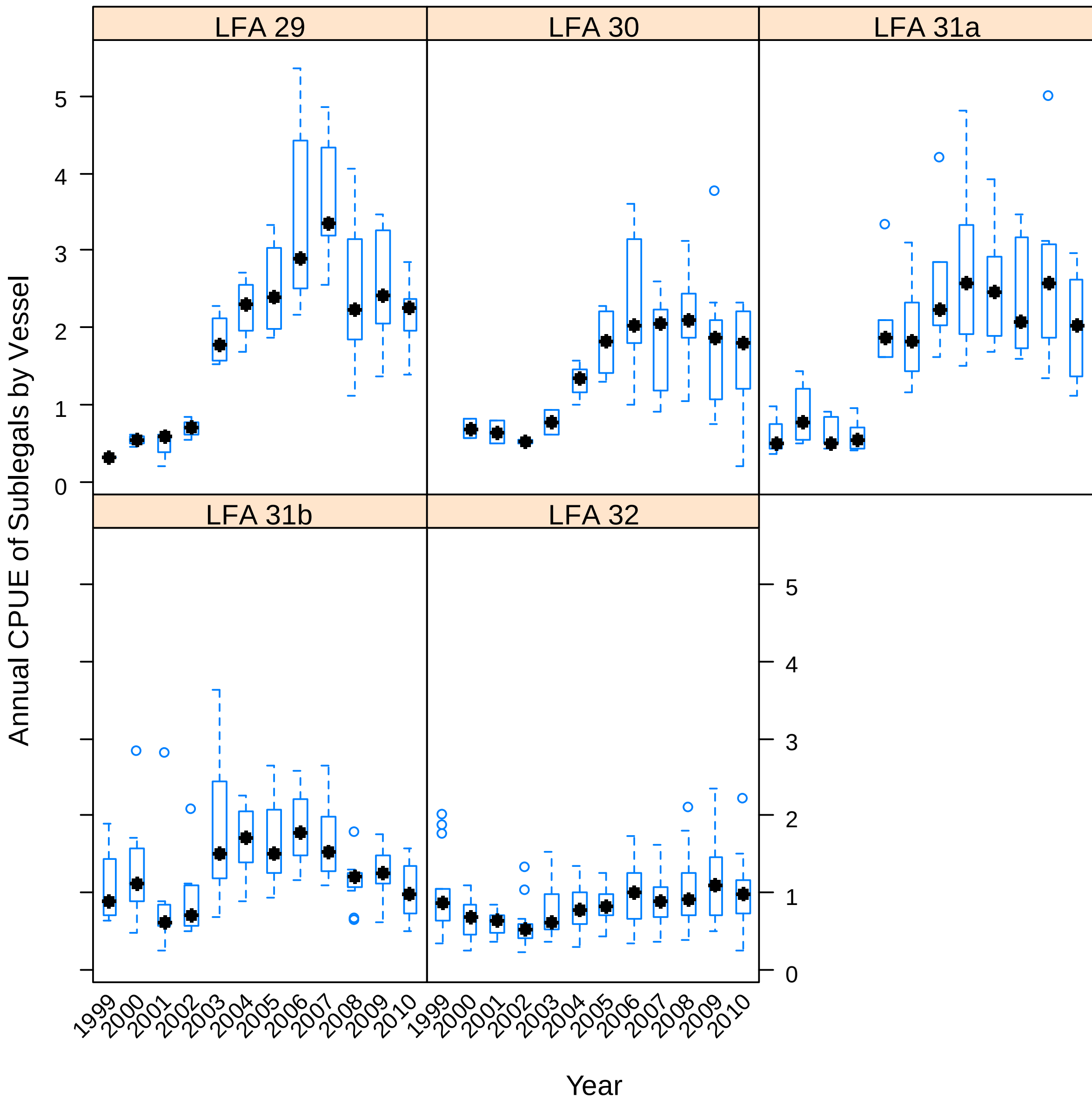


Figure 4.10. Box and whisker plots of raw annual CPUE of sublegals for FSRS participants in LFAs 29-32. Annual CPUE = total number of sublegal lobsters/total number of FSRS trap hauls. See Fig. 4.1 for description of box plot symbols.

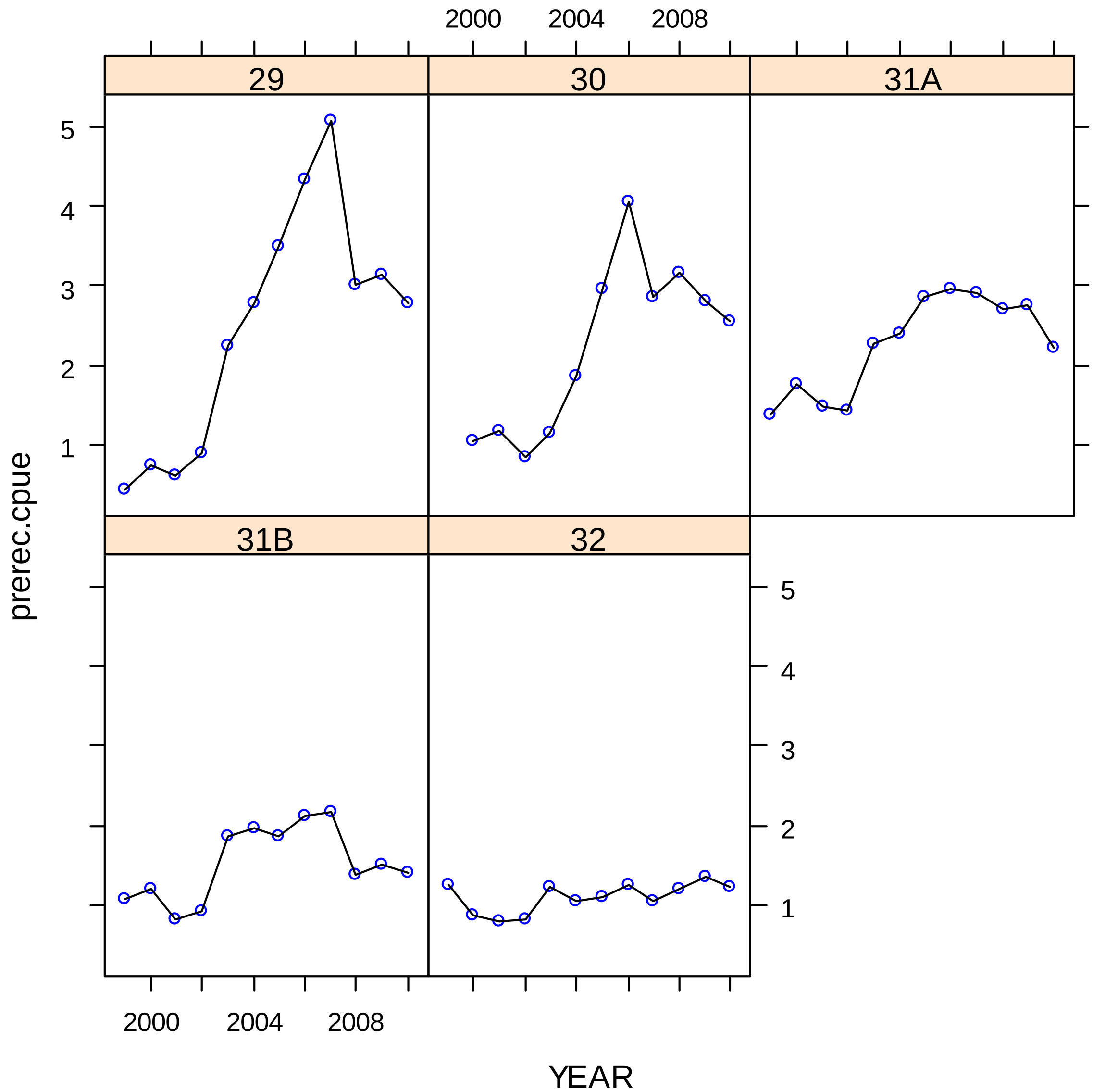


Figure 4.11. Predicted values of sublegal CPUE for LFA 29-32 LFAs from GLM models of FSRS recruitment trap data. Note that each LFA modeled separately. Predictions are for week=9.

```
[xyplot(prerec.cpue~YEAR|factor(LFA),data=y,type="b",as.table=T,ylab="Predicted
prerecruit CPUE")]
```

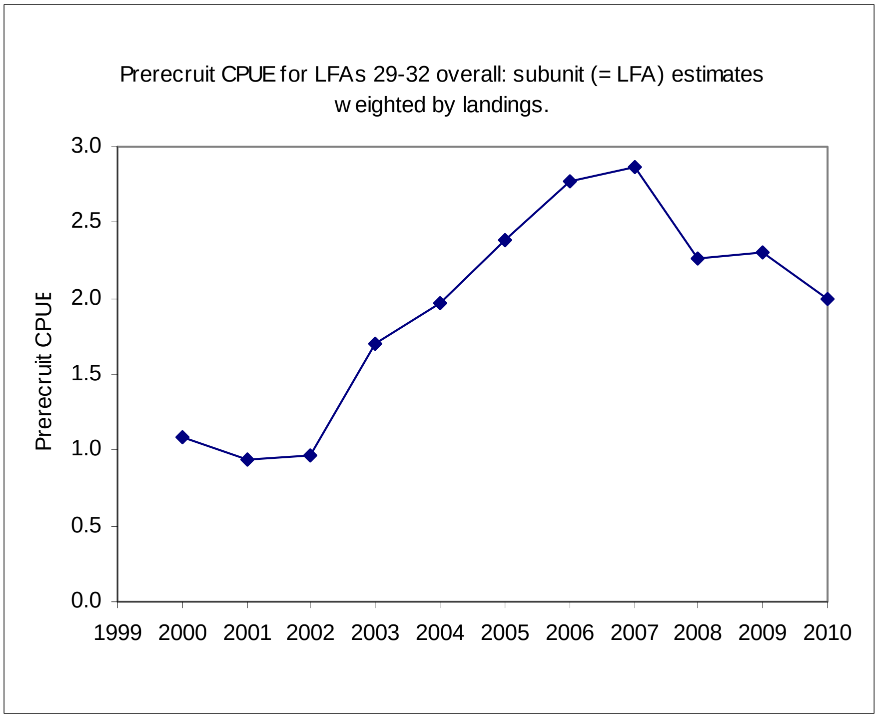


Figure 4.12. CPUE index of sublegal sizes for LFAs 29-32 as a whole created by weighting the estimates in Fig. 4.11 by the landings.

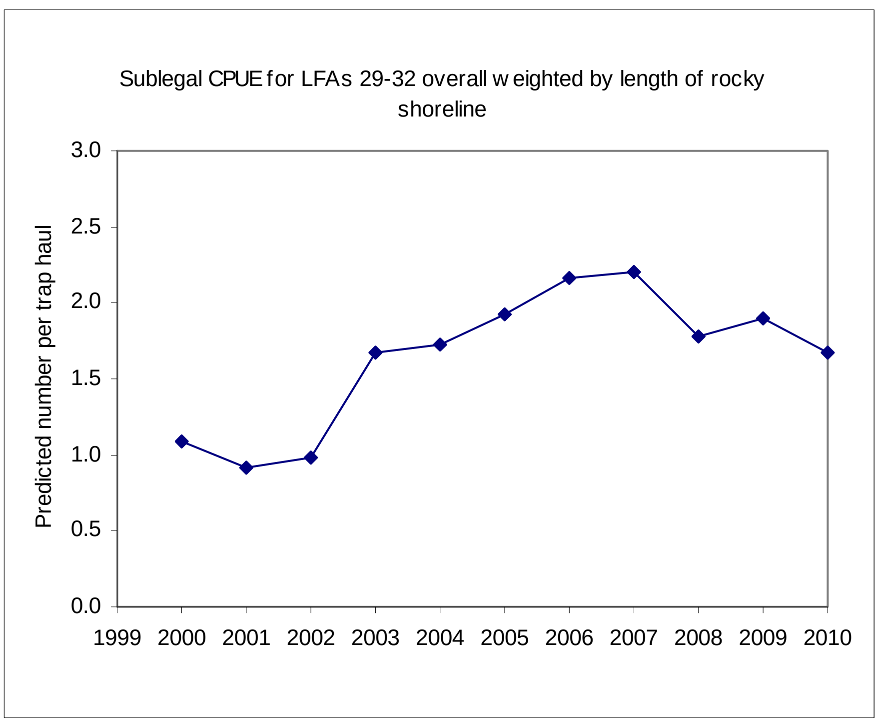


Figure 4.13. CPUE index of sublegal sizes for LFAs 29-32 as a whole created by weighting the estimates in Fig. 4.11 by the length of rocky shoreline as estimated by Hudon (1994).

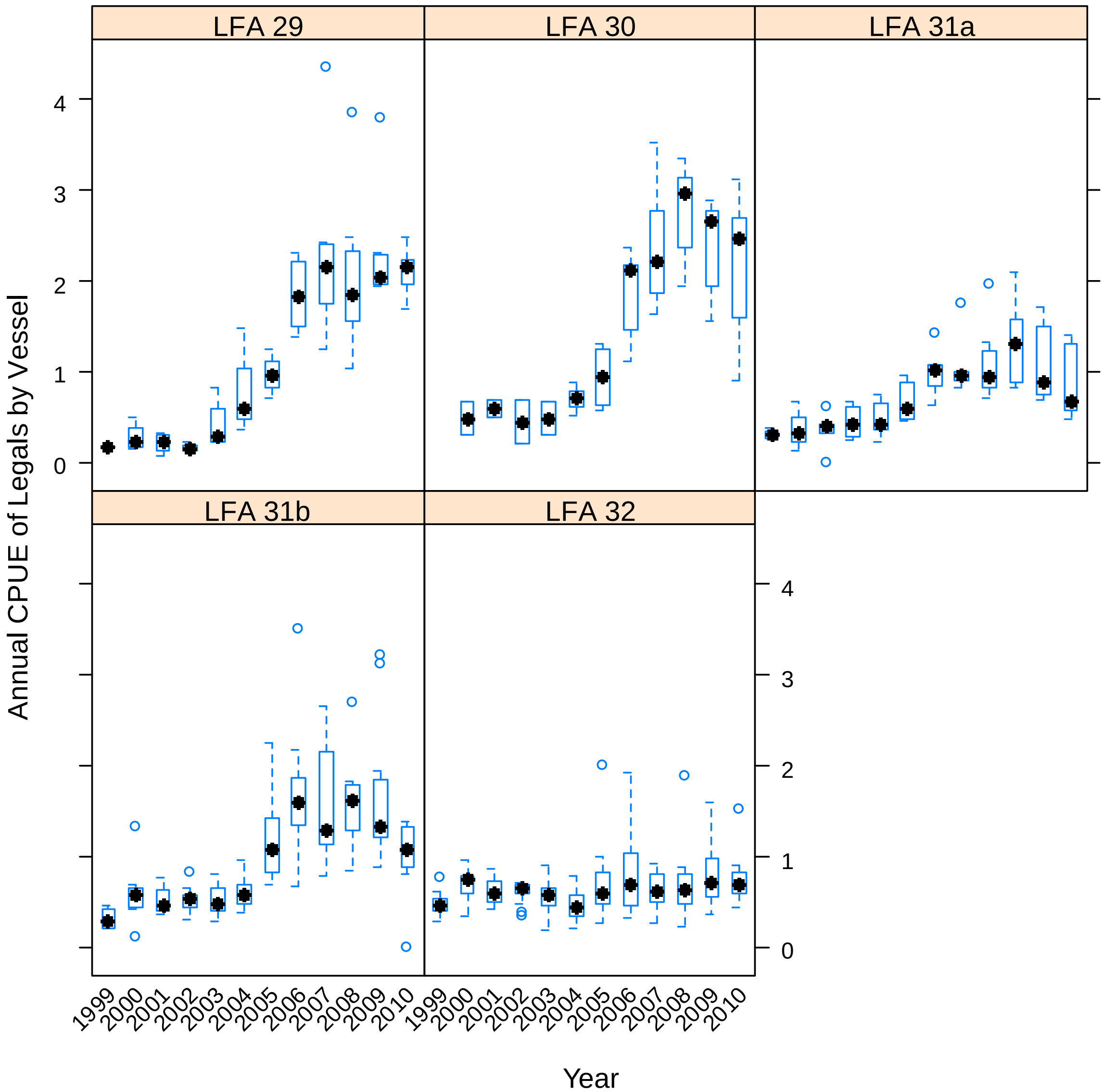


Figure 4.14. Box and whisker plots of raw annual CPUE of legal sizes for FSRS participants in LFAs 29 to 32. Annual CPUE = total number of legal lobsters/total number of FSRS trap hauls. See Fig. 4.1 for description of box plot symbols.

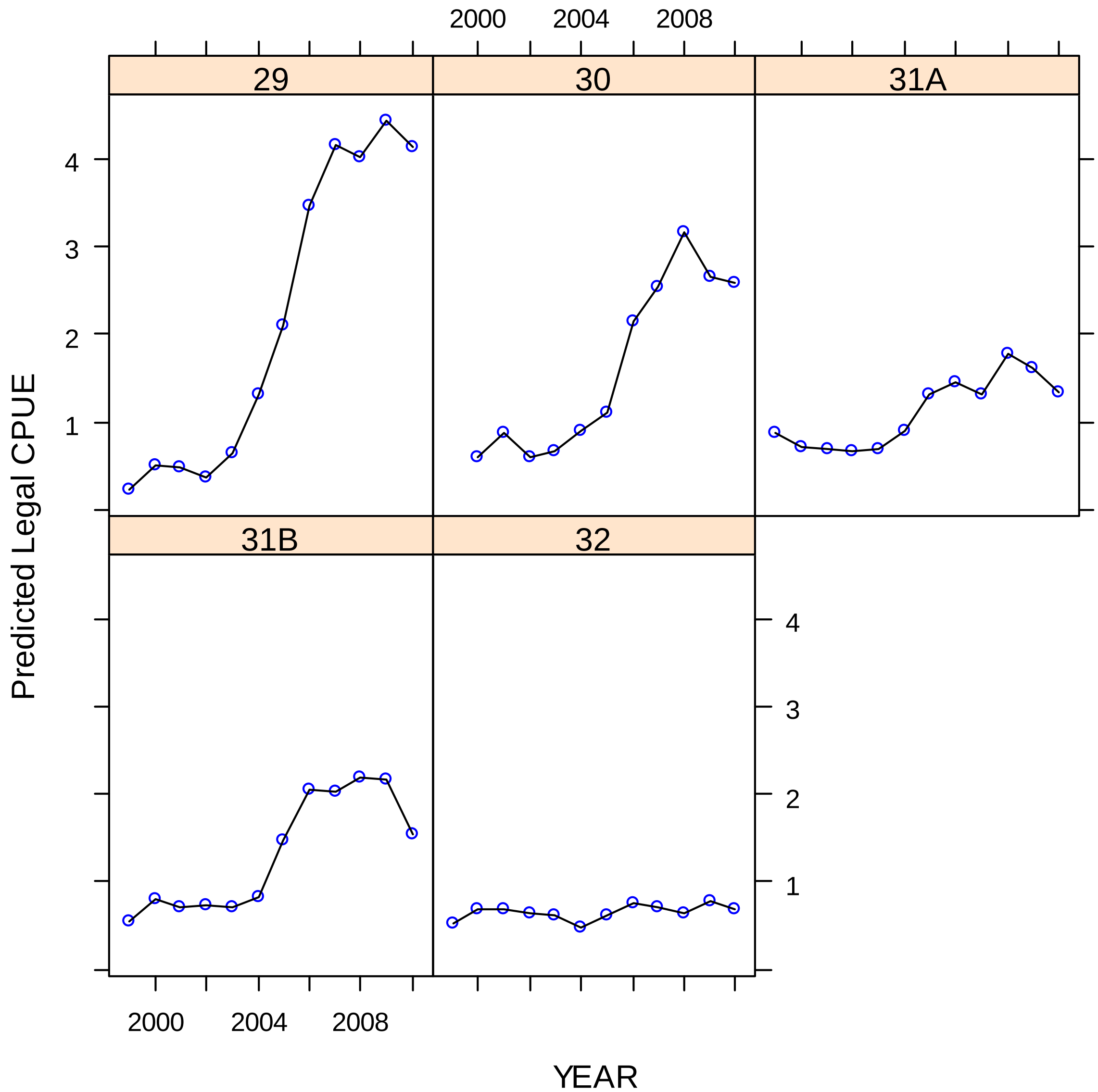


Figure 4.15. Predicted values of legal size CPUE for LFA s 29-32 from GLM models of FSRS recruitment trap data. Note that each LFA modeled separately. Values are predicted for week=0.

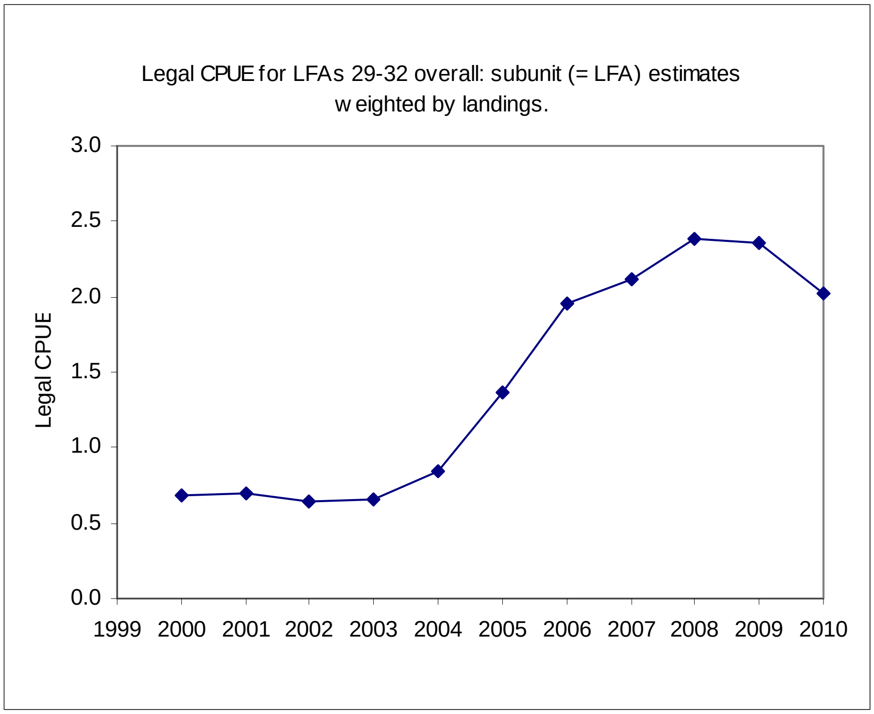


Figure 4.16. CPUE index of legal sizes for LFAs 29-32 as a whole created by weighting the estimates in Fig. 4.15 by the landings.

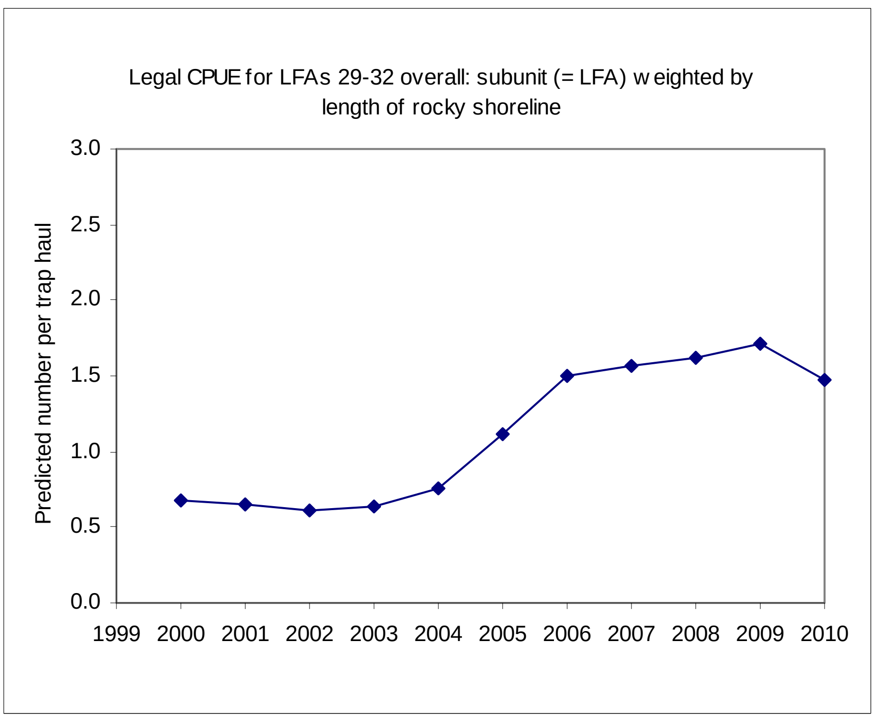


Figure 4.17. CPUE index of legal sizes for LFAs 29-32 as a whole created by weighting the estimates in Fig. 4.15 by the length of rocky shoreline.

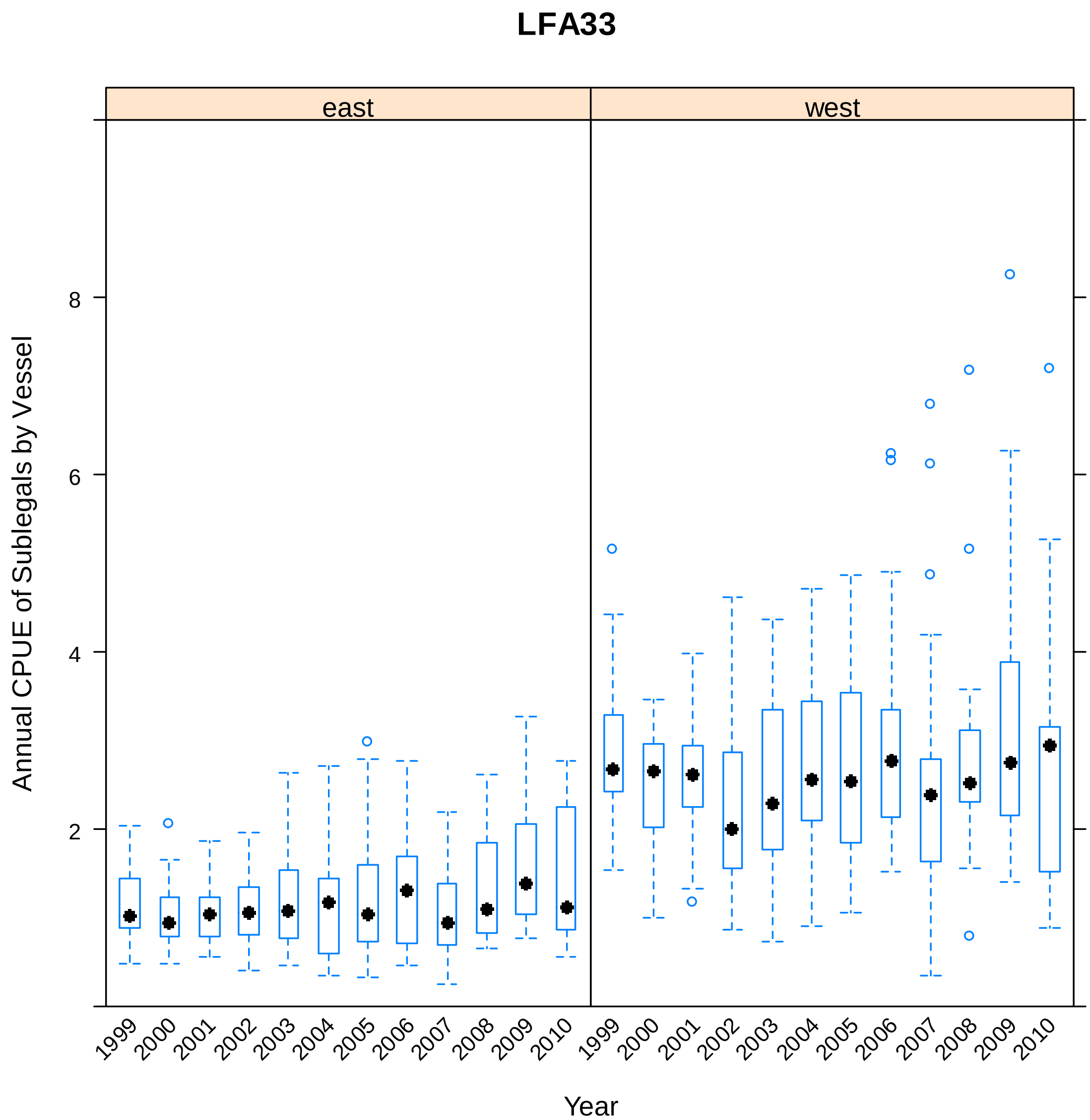


Figure 4.18. Box and whisker plots of raw annual CPUE of sublegals for FSRS participants in LFA 33, east and west subunits. Annual CPUE = total number of sublegal lobsters/total number of FSRS trap hauls. Two outliers with values of 14 and 16 lobsters per trap haul are not shown (2009 and 2010, West). Year shown is for the January to May portion of fishing season e.g. Year = 2010 is for fishing season 2009-2010. See Fig. 4.1 for description of box plot symbols.

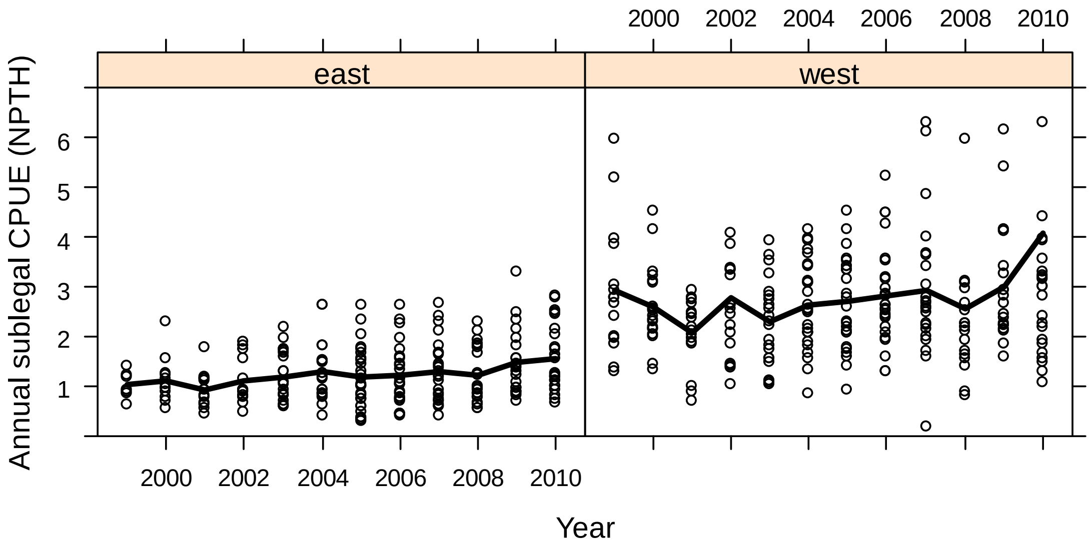


Figure 4.19. Unstandardized CPUE for sublegals in FSRS traps for LFA 33 East and West. Each point is the annual CPUE for one fisherman; solid line is annual mean. Three points between 10 and 16 in 2010 (West) are not shown.

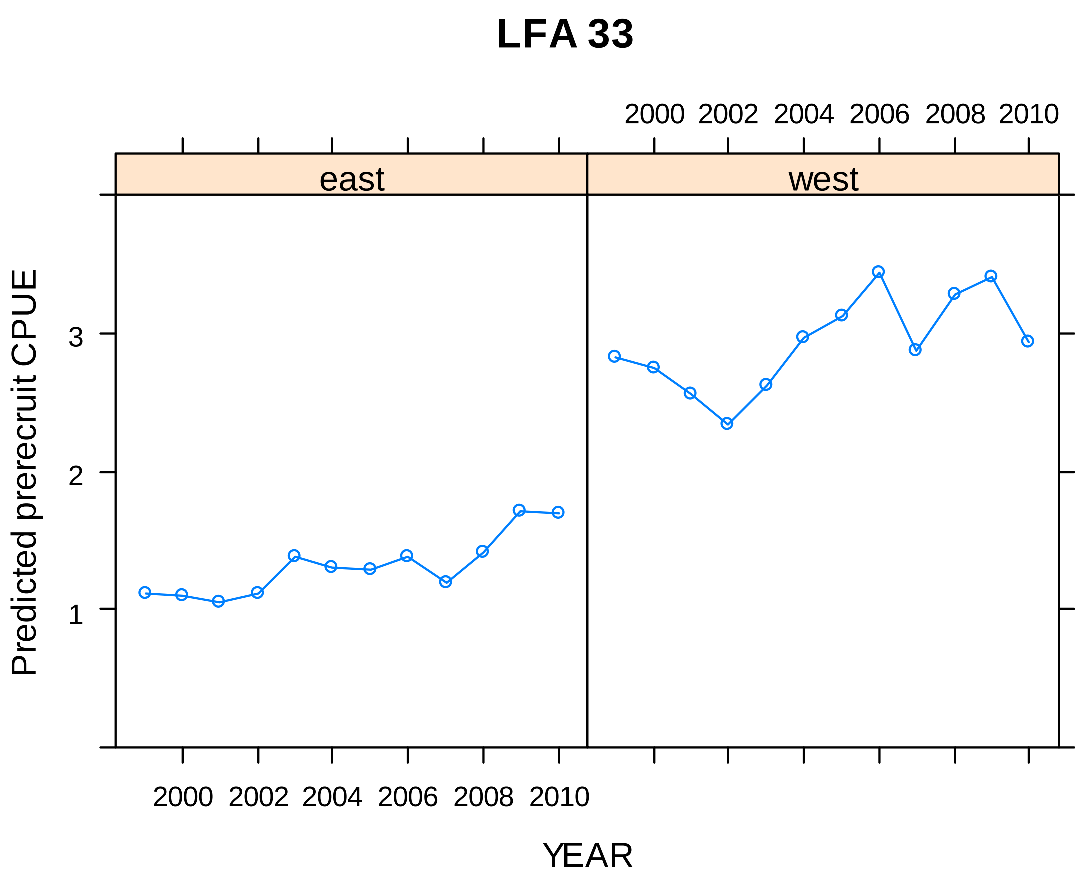


Figure 4.20. Predicted values for sublegal CPUE for LFA 33 from GLM models of FSRS recruitment trap data. Note that east and west subunits were modeled separately. Predictions are for week=27 (last week of season).

```
xyplot(prec.cpue~YEAR|factor(Subarea),data=x,type="b",as.table=T,ylim=c(0,4),
ylab="Predicted prerecruit CPUE",main="LFA 33")
```

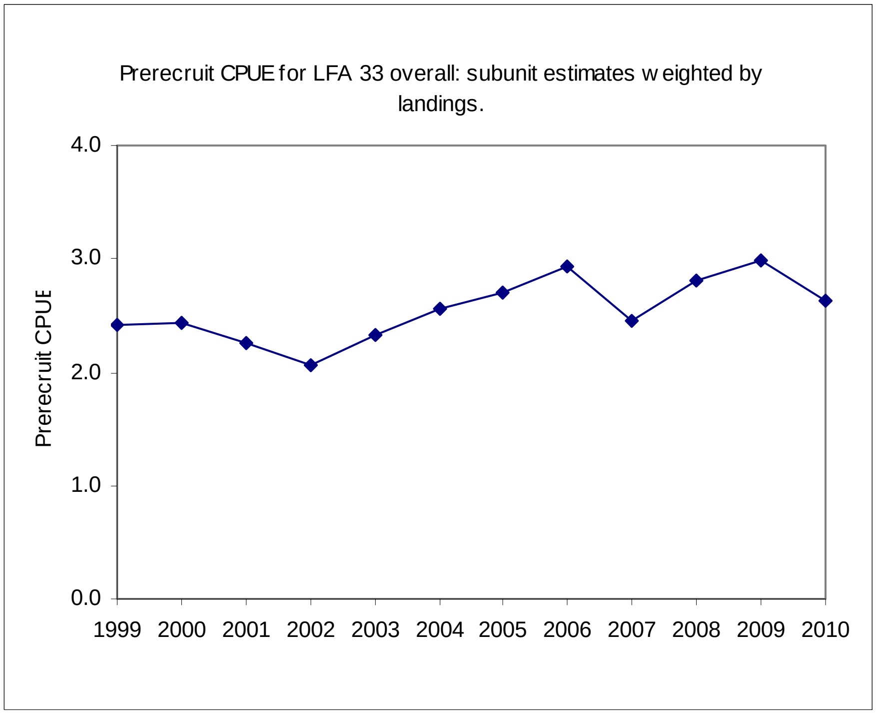


Figure 4.21. CPUE index of sublegal sizes for LFA 33 as a whole created by weighting the estimates in Fig. 4.20 by the landings.

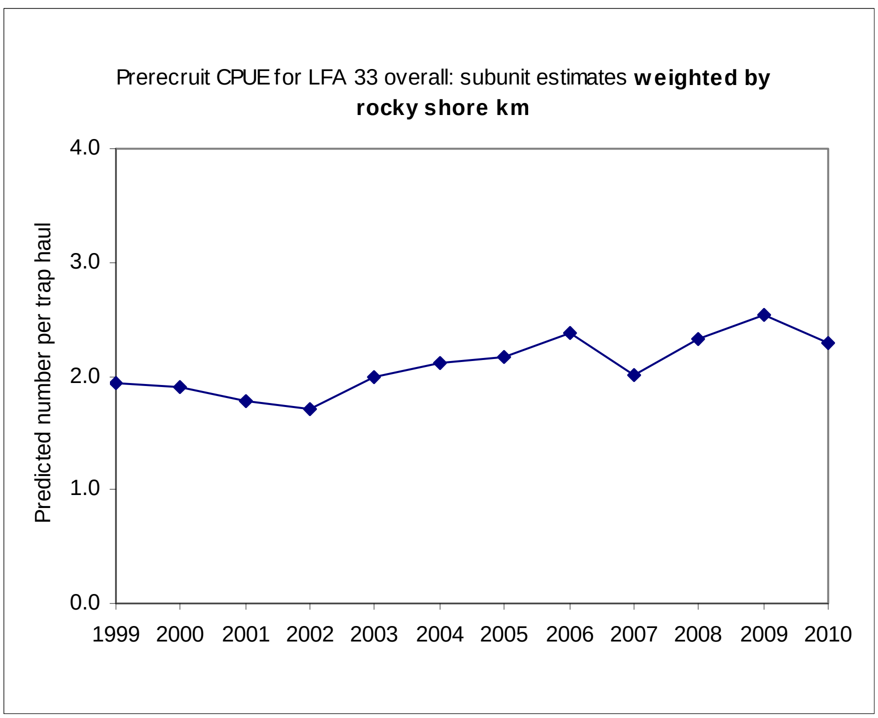


Figure 4.22. CPUE index of sublegal sizes for LFA 33 as a whole created by weighting the estimates in Fig. 4.20 by the length of rocky shoreline.

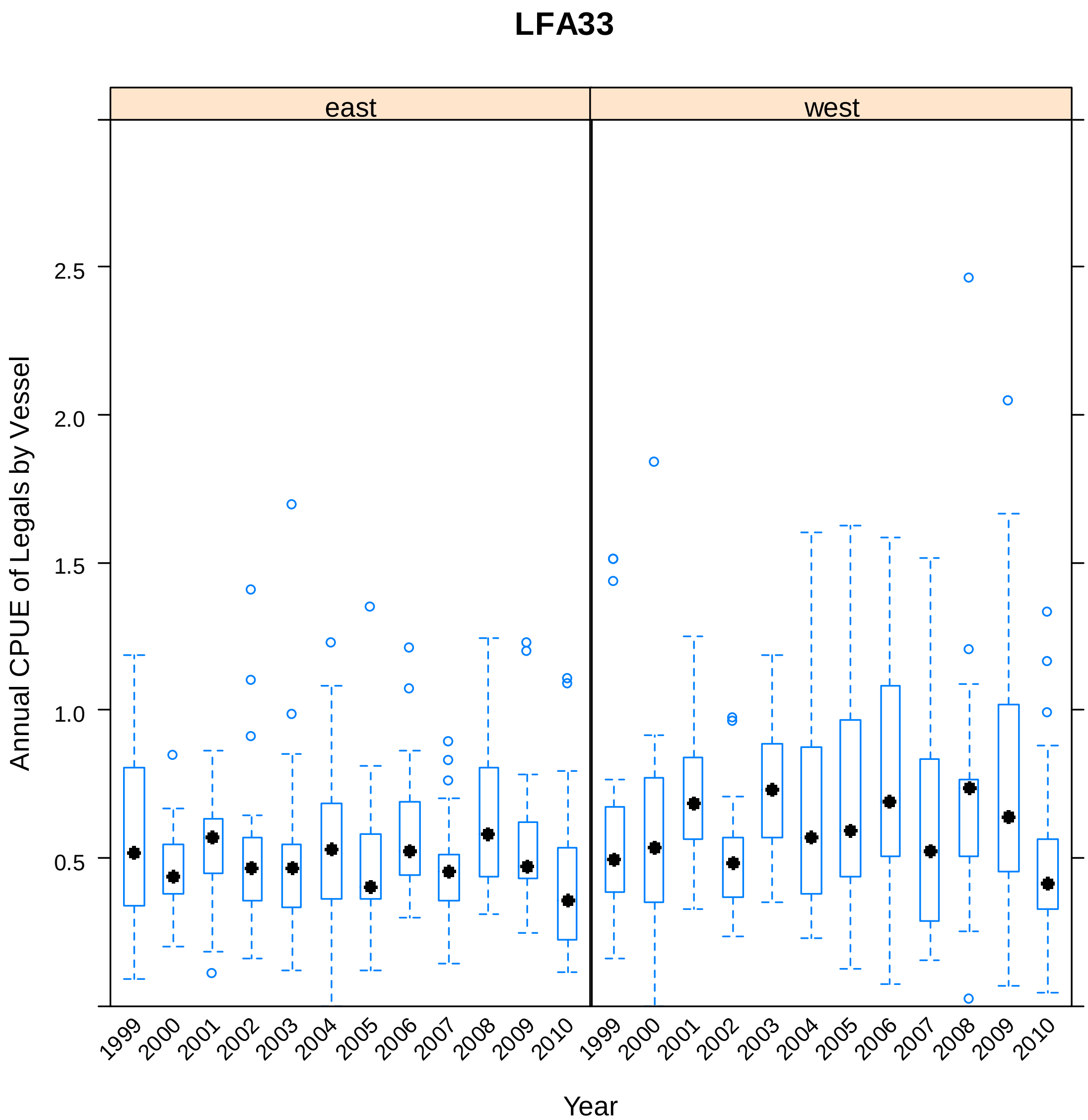


Figure 4.23. Box and whisker plots of raw annual CPUE of legal sizes for FSRS participants in LFA 33, east and west subunits. Annual CPUE = total number of sublegal lobsters/total number of FSRS trap hauls. An outlier with a value of 4.2 lobsters per trap haul is not shown (2004, West). Year shown is for the January to May portion of fishing season e.g. Year = 2010 is for fishing season 2009-2010. See Fig. 4.1 for description of box plot symbols.

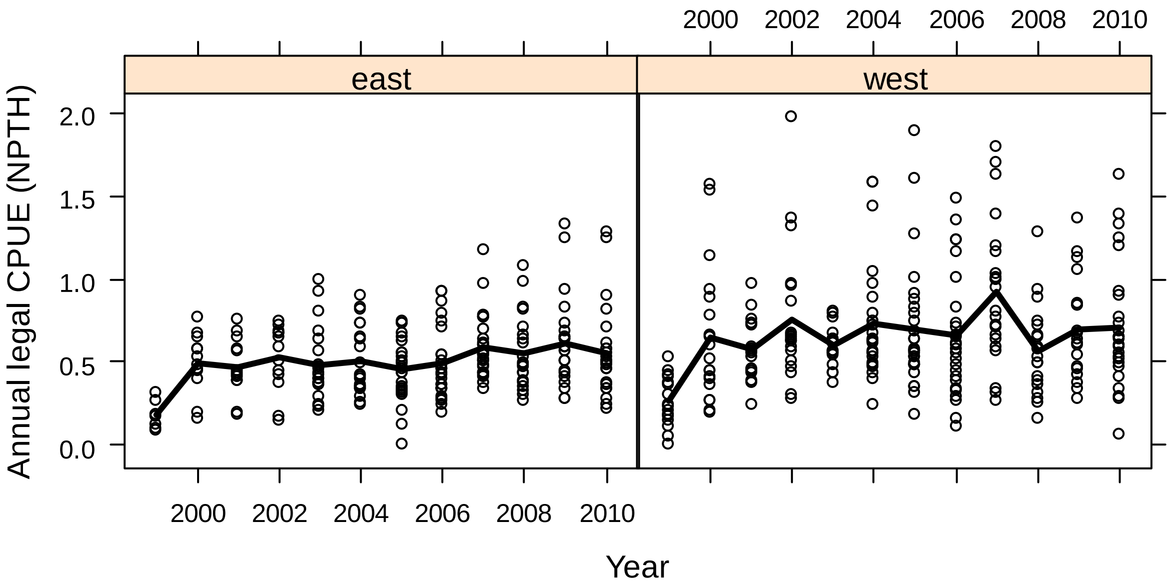


Figure 4.24. Unstandardized CPUE for legal sizes in FSRS traps for LFA 33 East and West. Each point is the annual CPUE for one fisherman; solid line is annual mean.

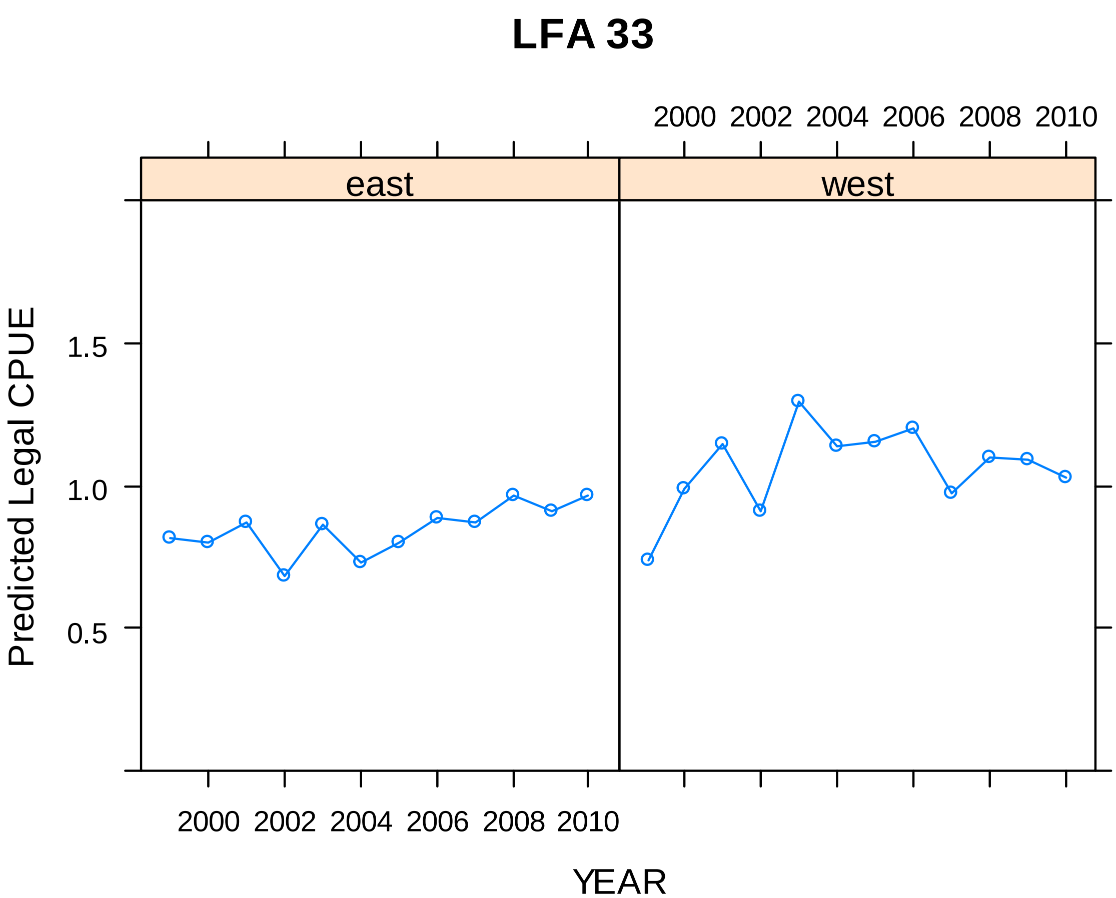


Figure 4.25. Predicted values for CPUE of legal sizes for LFA 33 from GLM models of FSRS recruitment trap data. Note that east and west subunits were modeled separately. Predictions are for week=0.

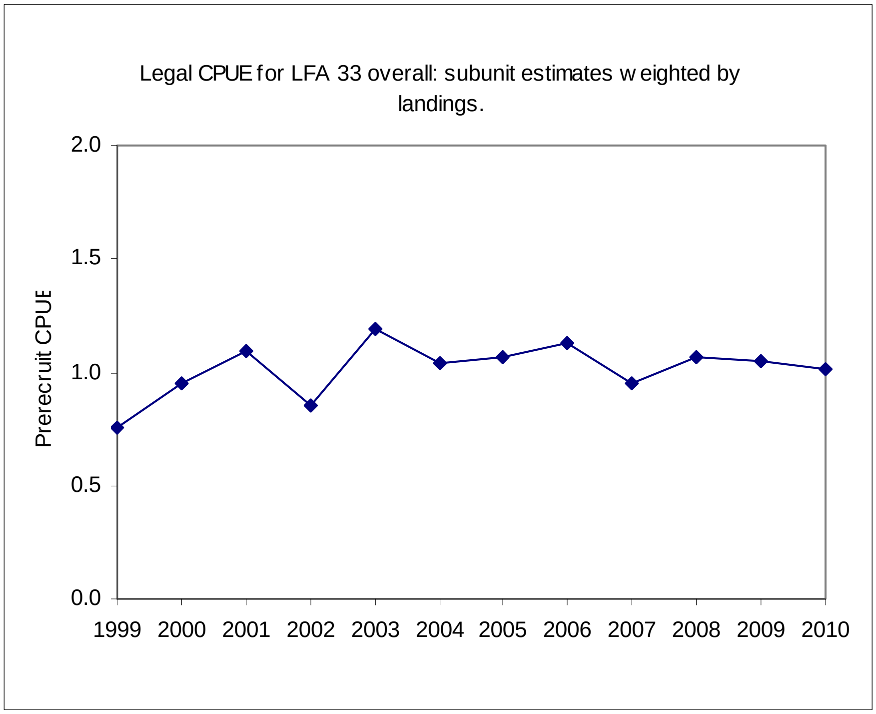


Figure 4.26. CPUE index of legal sizes for LFA 33 as a whole created by weighting the estimates in Fig. 4.25 by the landings.

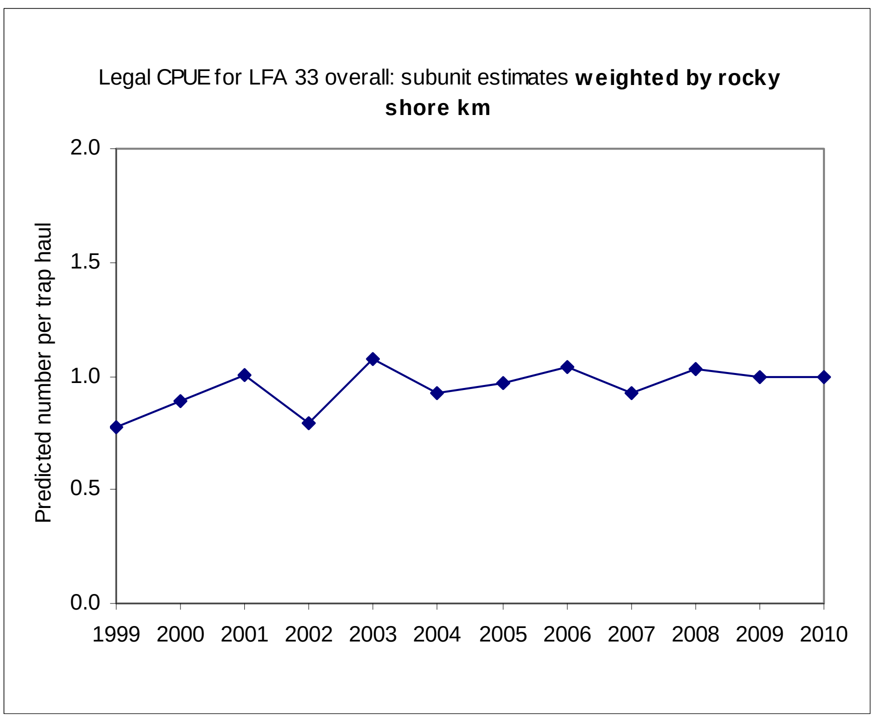


Figure 4.27. CPUE index of legal sizes for LFA 33 as a whole created by weighting the estimates in Fig. 4.25 by the length of rocky shoreline.

5. FISHING PRESSURE

5.1. METHODS

To estimate Exploitation Rate (ER), we used the CCIR (Continuous Change in Ratio) method as described in Tremblay et al. 2011. The ER estimates (also known as "removal rate") should be considered an index since CCIR does not generate absolute estimates of exploitation because ovigerous females are not accounted for by the method. The year to year trends in the ER of the exploitable population are captured by CCIR.

CCIR estimates ER for a size fraction of the exploitable stock based on the change in ratio of the harvestable fraction to an unharvestable ("reference") fraction. To avoid potential problems with differential catchability, it is best to limit the exploitable sizes to those close to the reference size class. As such, the ER estimates provided are for lobsters between 81 and 90 mm CL, a size fraction that makes up a high proportion of the catch in all subunits. This size fraction is highly relevant, but it is important to recognize that the CCIR estimates do not include the larger size fractions. We cannot assume that the CCIR estimates presented are representative of all sizes.

The approach by assessment unit follows:

5.1.1. LFA 27

i. Exploitation rate was estimated for males and females for each year and subunit, 1999-2010. The exploited size group was 81-90 mm CL, the reference size group 71 mm CL to MLS.
ii. To get overall estimates for each year ("Weighted ER"), we first took the mean of the male and female estimates for each year and subunit. We then weighted these subunit estimates by their landings to provide an estimate for the overall assessment unit. Estimates from CCIR that were negative were excluded from the above procedure.
iii. Extended estimates for males and females for each year and subunit, 1999-2010 were estimated in CCIR using modified R code (J. Allard, June 2011, pers. comm.). The exploited size group was 76-90 mm CL, the reference size group was 71 mm CL to MLS. Note that for the estimates for 2007-2010, the extended estimates include the newly protected sizes (MLS increase) with the exploited size class.

5.1.2. LFAs 29-32

i. Exploitation rate was estimated for males and females for each year and subunit (= LFA for this assessment unit), 1999-2010. The exploited size group was MLS to 90 mm CL, the reference size group 76 mm CL to MLS.
ii. A weighted ER was estimated for LFAs 29-32 overall in the same way as for LFA 27.

5.1.3. LFA 33

i. Exploitation rate was estimated for males and females for each year and subunit (East, West), 1999-2010. Exploited size: 82.5-90 mm CL, reference size 76 to 82 mm CL
ii. A weighted ER was estimated for LFA 33 overall in the same way as for LFA 27.

5.2. RESULTS AND DISCUSSION

5.2.1. LFA 27

The results for LFA 27 are displayed in Table 5.1 and Fig. 5.1. Confidence intervals tended to be narrower later in the time series, likely because of the higher numbers of lobsters sampled (Fig. 5.2). This increase reflects an increased number of participants over the period (Table 3.11 in Tremblay et al. 2011). Considering trends by sex and subunit, LFA 27 has fluctuated largely without trend since 1999. The exception is the ER for females in SD 6-7, which has had a downward trend in the last 4 years (Fig. 5.1). Weighted estimates for LFA 27 as a whole (Fig. 5.3) again indicate overall exploitation rates have fluctuated without trend. Mean estimated ER for 2008-2010 (0.77) is close to the median for 1999-2007 (0.76).

The extended estimates of ER for LFA 27 (Fig. 5.4) indicate that the increased MLS has had a substantial effect on reducing exploitation. The mean of the extended estimates for 2009 and 2010 was 0.50 (areas and sexes averaged), compared to the median for 1999-2008 of 0.70. This represents a reduction of almost 30%. There is a case to be made for using the extended estimates into the future, but given that conventional measures of ER are of the exploited population, and that other lobster assessment units use this measure, it is proposed to calculate only the strict ER estimates in the future, keeping in mind that CCIR is an index. Assessments of LFA 27 will show other conservation benefits from the increase in MLS, mainly higher abundance of spawners.

The exploitable stock in LFA 27 no longer includes a large fraction of the former catch (70-76 mm CL, retained as recently as 1997 and 76-81 mm CL, retained until the end of the 2006 season), and the stock has been sustained at the levels indicated by the strict ER estimates over the last 10 years. It is highly unlikely that current levels of exploitation threaten sustainability of lobsters in LFA 27. If the physical or environmental conditions were to change significantly and become less suitable for lobsters, this would need to be re-evaluated.

5.2.2. LFAs 29-32

The results for LFAs 29-32 are shown in Table 5.2 and in Figure 5.5. Sampled numbers (Fig. 5.6) were too low to derive estimates for LFA 28.

With regard to ER estimates by sex and subunit (Fig. 5.5), most estimates had wider confidence intervals than for LFA 27, perhaps because of the lower numbers sampled. Confidence intervals tended to narrow over the period 1999-2010, coincident with the increased sample size (Fig. 5.6). LFAs 29 and 30 showed downward trends in ER in the last 4-5 years; the other LFAs fluctuated without trend (Fig. 5.6). The weighted ER estimates for LFAs indicate a slight downward trend, with an unexplained trough in 2003 (Fig. 5.7). The most recent estimates are below the median and mean (Table 5.2). Mean ER for 2008-2010 (0.61) is below the median for 2000-2007 (0.70).

Exploitation rates as high as or higher than current levels allowed a pulse of recruits to come through that were still in the fishery in the 2010 season (Section 4). Lower exploitation rates may have extended the benefits of this pulse but current levels of ER appear sustainable under current conditions. It is highly unlikely that current levels of exploitation threaten sustainability of lobsters in LFAs 28-32. If the physical or environmental conditions were to change significantly and become less suitable for lobsters, this would need to be re-evaluated.

5.2.3. LFA 33

Results of LFA 33 are shown in Table 5.3 and Fig. 5.8. Confidence intervals for ER estimates by sex and subunit (Fig. 5.8) were relatively narrow from 2005 onwards, coincident with increased sample sizes (Fig. 5.9). ER estimates for males fluctuated mainly without trend but there was some downward trend in the estimates for females (Fig. 5.8). The weighed ER estimates (Fig. 5.10) show this slight downward trend. Mean ER for 2007-2008 to 2009-2010 (0.67), is below the median for 1999-2000 to 2006-2007 (0.76).

Given that the resource has performed well over the period of ER estimates, it is highly unlikely that current levels of exploitation threaten sustainability of lobsters in LFA 33. If the physical or environmental conditions were to change significantly and become less suitable for lobsters, this would need to be re-evaluated.

5.3. 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 estimates of yield per recruit for some of these LFAs (Miller et al. 1987) indicated yield per recruit would increase with decreased effort or increased minimum legal size.

A yield per recruit analysis was outside the scope of this assessment and would have to account for changes since the last analysis, such as 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.

5.4. SUMMARY

Exploitation rate of lobsters between 81 and 90 mm CL was estimated for subunits of the assessment units LFA 27, LFAs 28-32, and LFA 33 with the Continuous Change in Ratio method. Overall, ER was estimated for each assessment unit by weighting the subunit estimates by landings. Confidence intervals around the subunit ER estimates were narrower where the sample size was higher.

Given the level of the most recent ER estimates in relation to those over the 1999-2010 period, and given that the fishery has been sustained over that time period, current levels of exploitation rate are unlikely to compromise sustainability under current environmental conditions.

See Table 5.4 for main conclusions and status by assessment unit.

Table 5.1. Exploitation rate for LFA 27 as a whole ("Weighted ER") derived by weighting CCIR estimates for subunits by landings. Mean ER = mean exploitation rate for males and females. 0.788, 0.747. Weighted ER values that were less than the 25th percentile (0.747) of the time series were classified as "positive", values between the 25th and 75th percentile (0.788) were classified as "neutral" and values greater than the 75th percentile were classified as "negative".

	Mean ER		Landings		
Year	SD 1,4	SD 6,7	SD 1,4	SD 6,7	Weighted ER
1999	0.717	0.642	624	785	0.675
2000	0.888	0.831	717	800	0.858
2001	0.731	0.791	834	997	0.763
2002	0.910	0.663	586	620	0.783
2003	0.749	0.792	672	720	0.772
2004	0.804	0.690	779	855	0.744
2005	0.835	0.693	758	1,005	0.754
2006	0.838	0.879	713	991	0.862
2007	0.800	0.668	701	1,102	0.719
2008	0.874	0.769	868	1,692	0.804
2009	0.753	0.744	716	1,345	0.747
2010	0.806	0.718	736	1,157	0.752
MEDIAN					0.759
MEAN					0.770

Table 5.2. Exploitation rate for LFAs 29-32 as a whole ("Weighted ER") derived by weighting estimates for subunits by landings. Mean ER = mean for males and females. Weighted ER values that were less than the 25th percentile (0.613) of the time series were classified as "positive", values between the 25th and 75th percentile (0.727) were classified as "neutral" and values greater than the 75th percentile were classified as "negative".

	Mean ER					Landings				
Year	LFA 29	LFA 30	LFA 31a	LFA 31b	LFA 32	LFA 28.29	LFA 30	LFA 31	LFA 32	Weighted ER
1999	NA	NA	0.961	NA	0.710	55	70	217	316	NA
2000	0.787	0.825	0.843	0.700	0.862	59	54	299	448	0.823
2001	0.666	0.861	0.787	0.779	0.816	71	98	304	433	0.798
2002	0.749	0.947	0.649	0.648	0.588	65	79	313	358	0.659
2003	0.725	0.830	0.847	0.357	0.239	138	73	431	389	0.498
2004	0.587	0.572	0.826	0.602	0.754	198	84	518	289	0.691
2005	0.947	0.614	0.724	0.660	0.684	411	112	924	403	0.742
2006	0.790	0.468	0.716	0.749	0.651	654	187	1497	601	0.712
2007	0.618	0.749	0.636	0.538	0.739	772	215	1821	620	0.632
2008	0.508	0.747	0.491	0.705	0.535	1043	399	1932	687	0.579
2009	0.672	0.277	0.690	0.543	0.618	1036	462	2171	776	0.594
2010	0.483	0.596	0.801	0.583	0.751	796	357	1817	611	0.646
Median										0.659
Mean										0.670

Table 5.3. Exploitation rate for LFA 33 as a whole ("Weighted ER") derived by weighting estimates for subunits by landings. East corresponds to SD 21-26; West corresponds to SD 27-31. Mean ER = mean for males and females. Weighted ER values that were less than the 25th percentile (0.671) of the time series were classified as "positive", values between the 25th and 75th percentile (0.785) were classified as "neutral" and values greater than the 75th percentile were classified as "negative".

	Mean ER		Landings		
Year	East	West	East	West	Weighted ER
1999	NA	0.527	733	2306	NA
2000	0.819	0.815	599	2530	0.816
2001	0.399	0.739	717	2872	0.671
2002	0.708	0.797	475	1638	0.777
2003	0.692	0.642	548	1755	0.654
2004	0.656	0.781	508	1602	0.751
2005	0.812	0.629	625	2066	0.671
2006	0.723	0.816	745	2278	0.793
2007	0.776	0.816	561	1630	0.806
2008	0.674	0.674	813	2384	0.674
2009	0.774	0.697	803	2423	0.716
2010	0.702	0.604	808	2404	0.628
Median					0.716
Mean					0.723

Table 5.4. Indicator table for Exploitation Rate (ER) estimates from Continuous Change in Ration (CCIR) from FSRS traps. Categorized as positive ("+") if median of overall index for last 3 years is <80% of the median for 1999-2010, or if extended estimates indicate a reduction in exploitation rate of more than 20% for the period; neutral ("N") if median of last 3 years is 80-120% of the median for 1999-2007 and negative if median of last 3 years is > 120% of median for 1999-2010.

Characteristic	Indicator/Source	Conclusions	Caveats	Overall status
Fishing pressure as indicated by exploitation rate – LFA 27	CCIR from LFA 27 FSRS recruitment traps	**Strict ER estimates for LFA 27 as a whole fluctuated without trend. Increased MLS has reduced exploitation overall (extended ER estimates). It is highly unlikely that current levels of exploitation threaten sustainability of lobsters in LFA 27 under current environmental conditions.** • Mean estimated ER for 2008-2010 (0.77) is close to the median for 1999-2007 (0.76). • Extended ER estimates provide some accounting for the fact that this area is no longer exploiting lobsters between 76 and 81 m CL. The extended ER estimates for 2009-2010 indicate ER is 29% lower than during the1999-2008 period.	• Estimates are only for smallest size group in fishery • Sizes in FSRS traps may not completely represent sizes in commercial traps • Conclusions do not consider yield per recruit	**+**
Fishing pressure as indicated by exploitation rate – LFAs 28-32	CCIR from LFA 29-32 FSRS recruitment traps	**ER estimates for LFAs 29-32 as a whole fluctuated widely with a slight downward trend. It is highly unlikely that current levels of exploitation threaten sustainability of lobsters in LFAs 28-32 under current environmental conditions.** • Mean ER for 2008-2010 (0.61) is below the median for 2000-2007 (0.70) • The slight downward trend in ER occurred in LFAs 29 and 30	• See above	**N**
Fishing pressure as indicated by exploitation rate – LFA 33	CCIR from LFA 33 FSRS recruitment traps	**ER estimates for LFA 33 as a whole fluctuated largely with a slight downward trend. It is highly unlikely that current levels of exploitation threaten sustainability of lobsters in LFA 33 under current environmental conditions.** • Mean ER for 2007-2008 to 2009-2010 (0.67), is below the median for 1999-2000 to 2006-2007 (0.76). • Some apparent small reduction in female exploitation	• See above; LFA 33 likely to have greater mismatch between FSRS traps & commercial	**N**

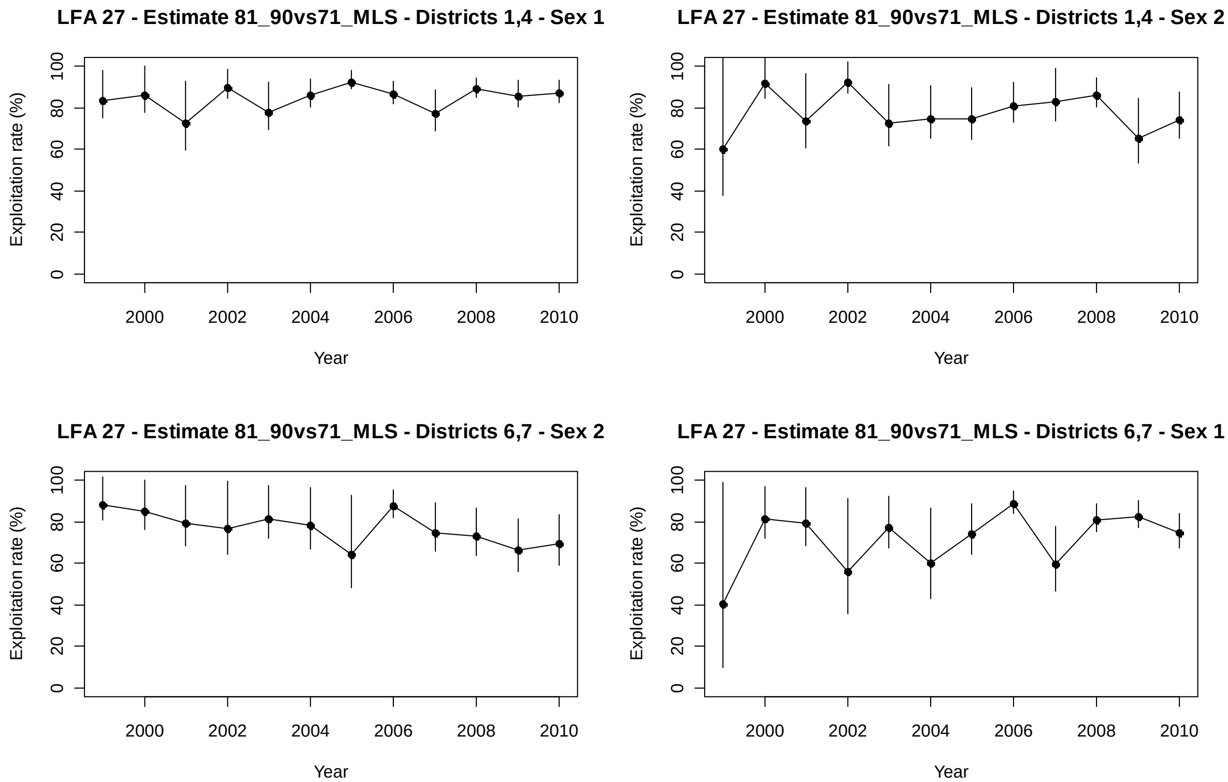


Figure 5.1. CCIR estimates with 95% confidence intervals for LFA 27.

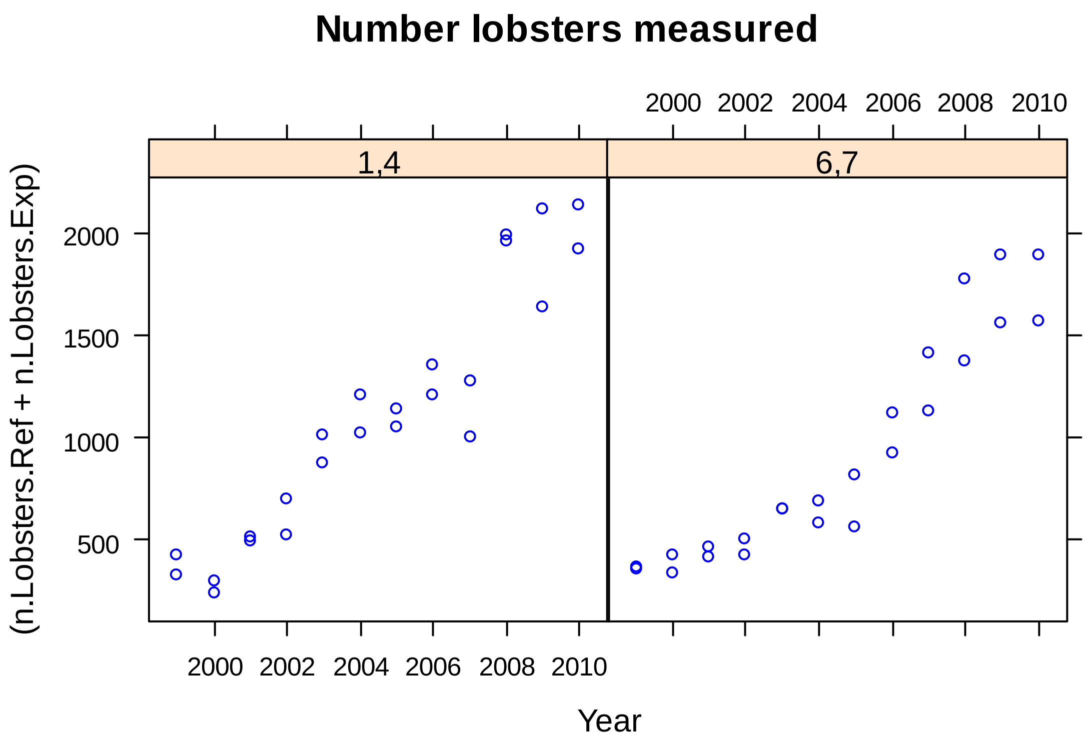


Figure 5.2. Numbers measured in FSRS traps (sum of number in reference and exploited groups) by year and subunit (SD 1 and 4; SD 6 and 7) for LFA 27. There are two points for each year---one is for males, the other for females.

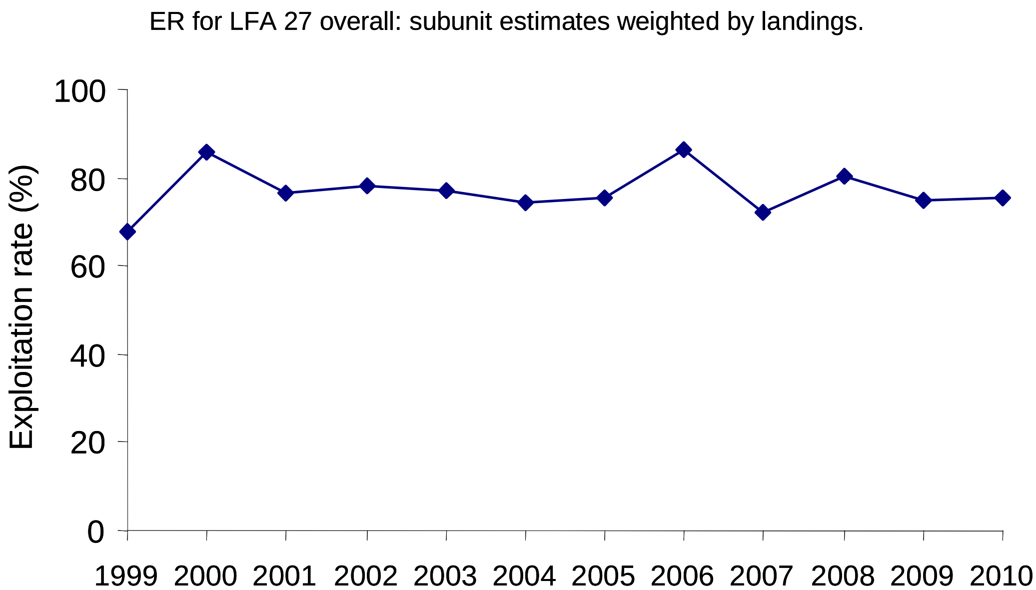


Figure 5.3. Exploitation rate for LFA 27 as a whole derived by weighting estimates for subunits by landings. See Table 5.1.

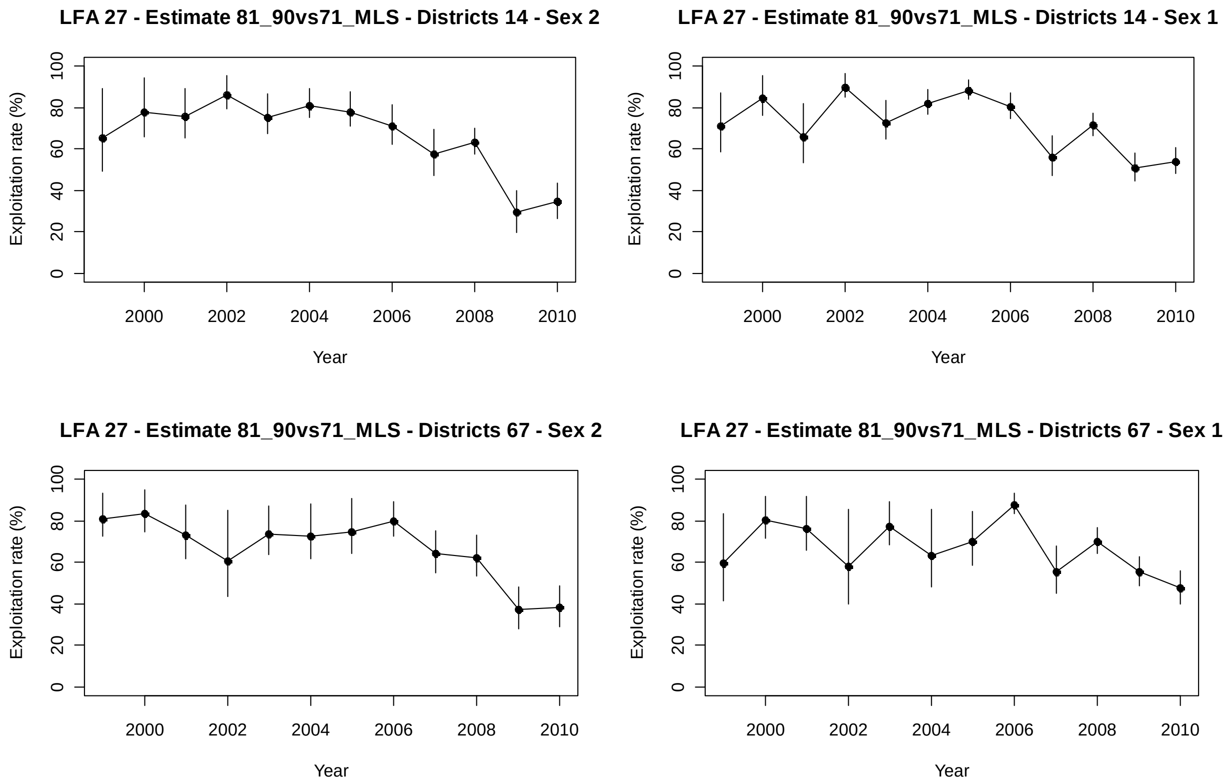


Figure 5.4. Extended CCIR estimates for LFA 27. Note that exploited class was 76-90, not 81-90 as indicated.

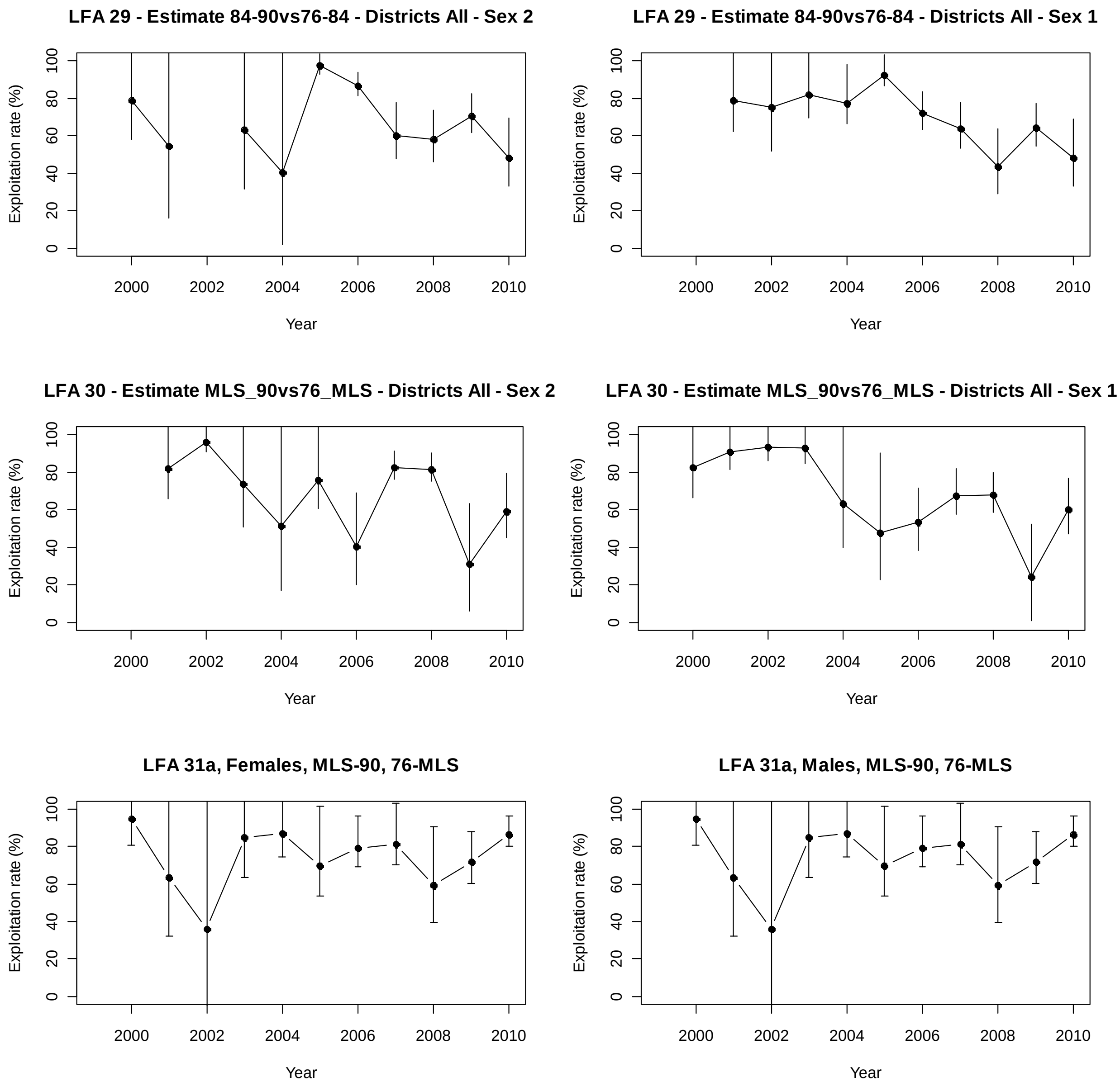


Figure 5.5. CCIR estimates with 95% confidence intervals for LFAs 29-32.

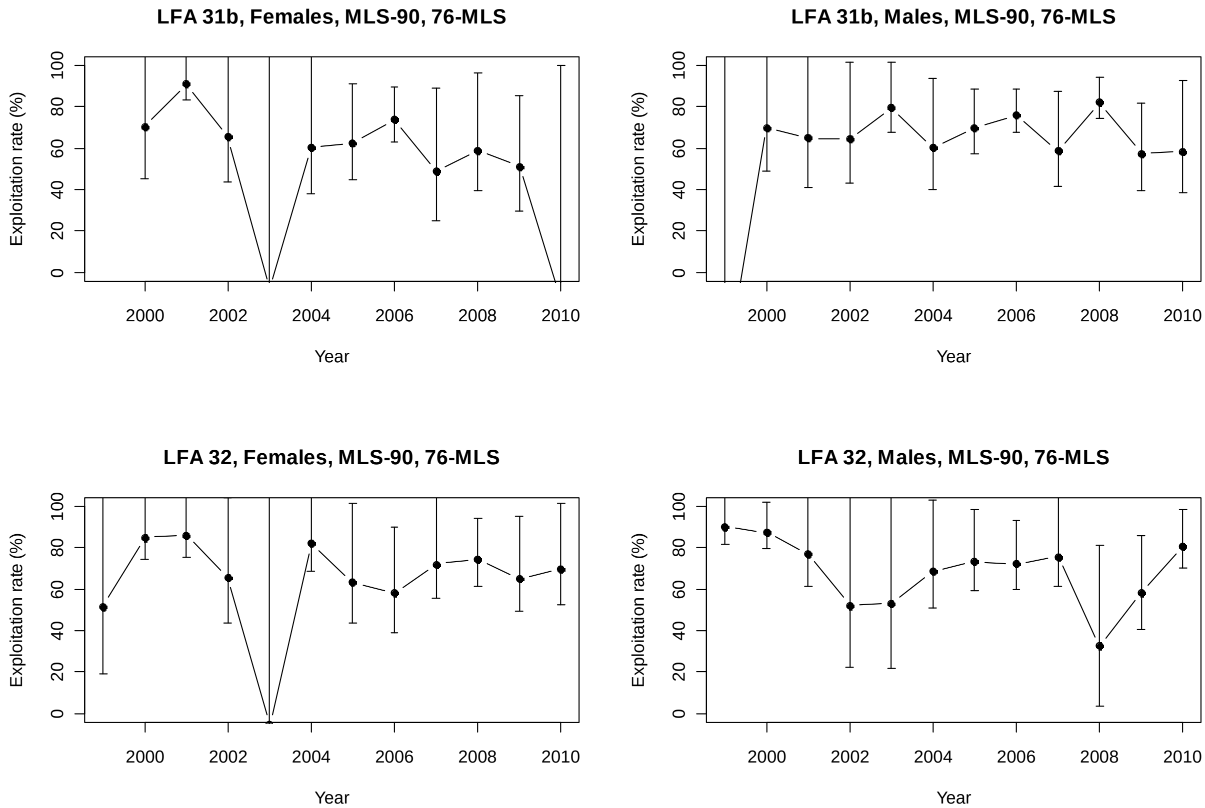


Figure 5.5, continued. CCIR estimates with 95% confidence intervals for LFAs 29-32.

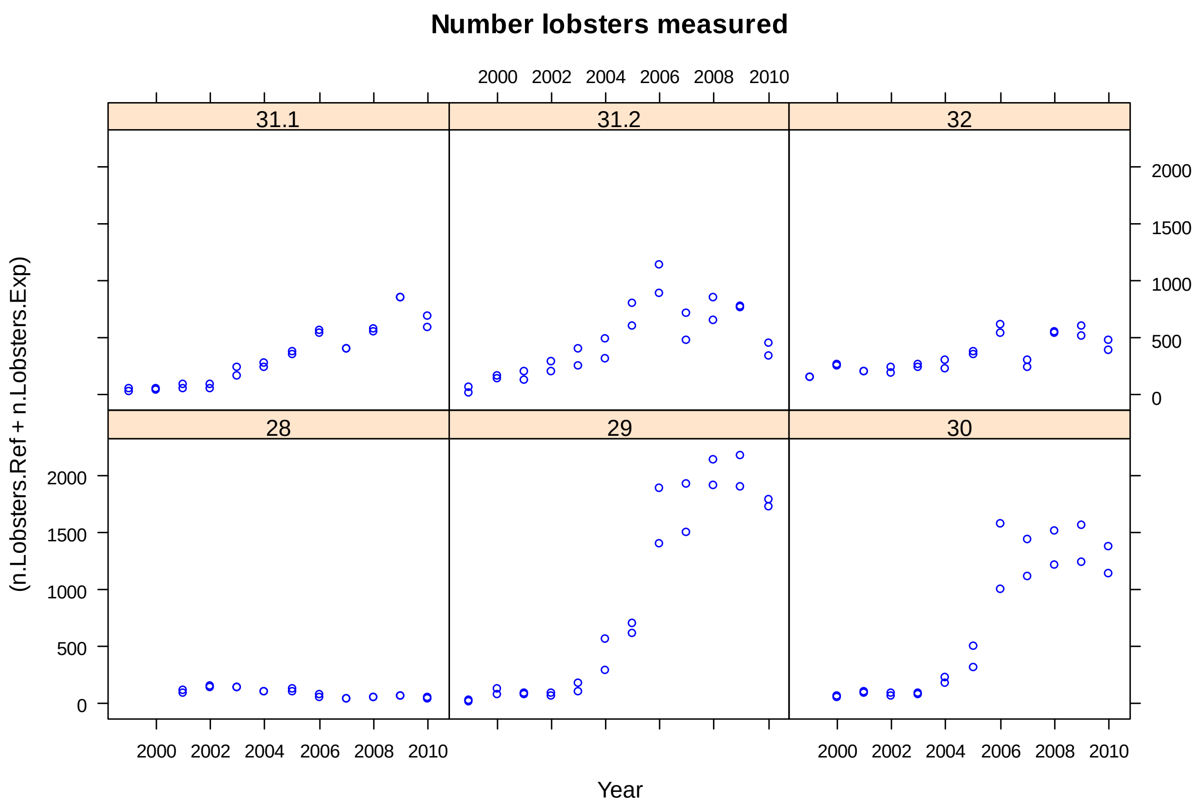


Figure 5.6. Numbers measured in FSRS traps (sum of number in reference and exploited groups) by year and subunit (= LFAs) for LFAs 28-32. There are two points for each year---one is for males, the other for females.

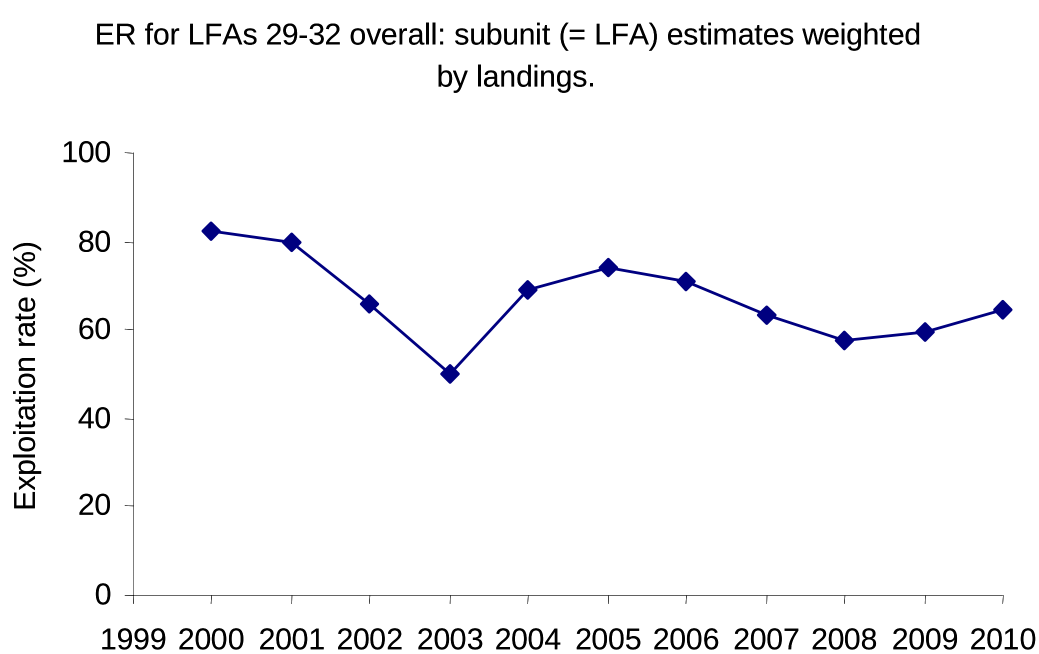


Figure 5.7. Exploitation rate for LFAs 29-32 as a whole derived by weighting estimates for subunits (= LFAs) by landings. See Table 5.2.

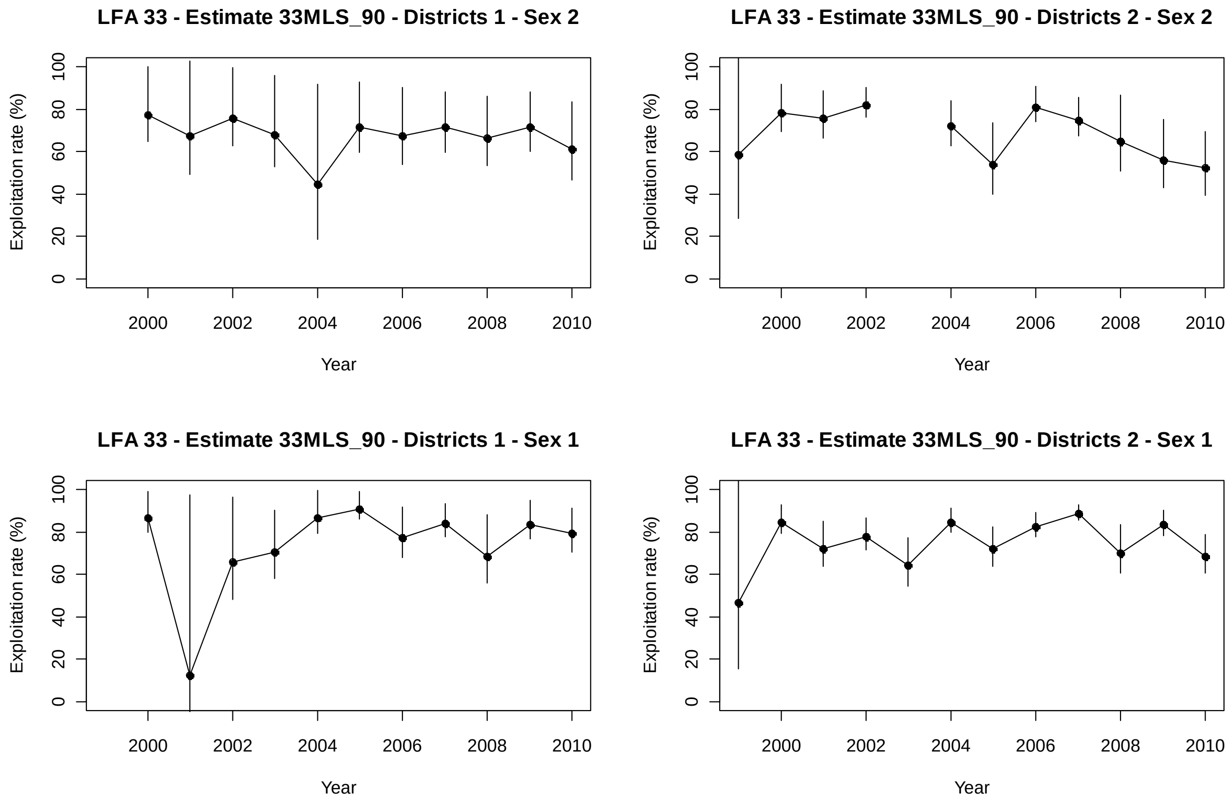


Figure 5.8. CCIR estimates with 95% confidence intervals for LFA 33. Estimates are by subunits East ("District 1") and West ("District 2"). East corresponds to SD 21-26; West corresponds to SD 27-31.

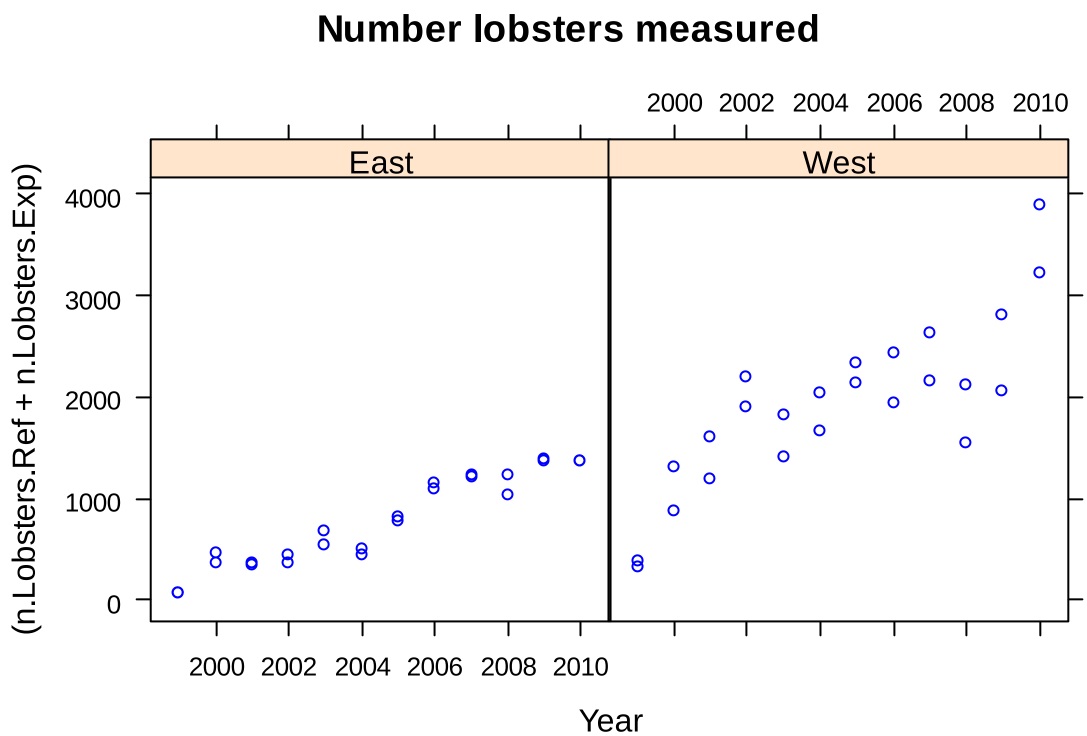


Figure 5.9. Numbers measured in FSRS traps (sum of number in reference and exploited groups) by year and subunit for LFA 33. There are two points for each year---one is for males, the other for females.

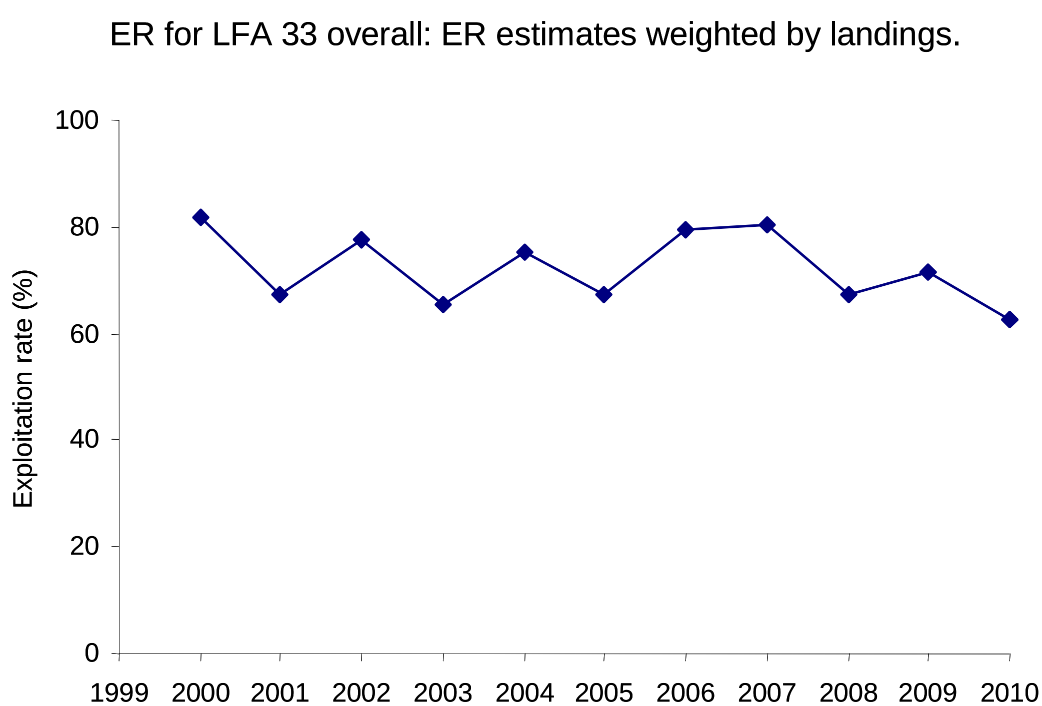


Figure 5.10. Exploitation rate for LFA 33 as a whole derived by weighting estimates for East and West subunits by landings. See Table 5.3

6. REFERENCES

Allard, J., R. Claytor, and J. Tremblay. 2011. Temperature-corrected abundance index of sub-legal lobsters in LFA 33 – 1999-2000 to 2008-2009. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/048.

Comeau, M., M. Mallet, and M. Smith. 2007. Variability in lobster, *Homarus americanus*, trap catches. Can. Tech. Rep. Fish. Aquat. Sci. 2757.

DFO. 2009. Biological basis for the protection of large lobsters in Lobster Fishing Areas 33 to 38. DFO Can. Sci. Advis. Sec. Sci. Resp. 2008/017.

DFO. 2011. Proceedings of the Maritimes Region Science Advisory Process to review the assessment framework for Lobster Fishing Areas (LFA) 27-33 lobster; February 1-3, 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/021.

Duggan, R.E., and R.J. Miller. 2002. Lobster fishing effort on the outer coast of Nova Scotia, 1983 versus 1998. DFO Can. Sci. Advis. Sec. Res. Doc. 2002/022.

Herrick, F.H. 1897. The protection of the lobster fishery. Bull. U.S. Fish. Comm.

Hudon, C. 1994. Large-scale analysis of Atlantic Nova Scotia American lobster (*Homarus americanus*) landings with respect to habitat, temperature, and wind conditions. Can. J. Fish. Aquat. Sci. 51(6): 1308-1321.

Knight, A.P. 1917. Official report upon lobster conservation in Canada. Suppl. to 51st annual report of the Fisheries Branch, Dep. Nav. Serv., 1916-17.

MacLean Commission, M. 1928. Report of the royal commission investigating the fisheries of the Maritime Provinces and the Magdalen Islands. King's Printer, Ottawa, On.

Miller, R.J., D.S. Moore, and J.D. Pringle. 1987. Overview of the inshore lobster resources in the Scotia-Fundy region. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 87/85.

Prince, E.E. 1899. Report of the Canadian Lobster Commission, 1898.

Rathbun, R. 1884. Notes on the decrease of lobsters. Bull.U.S. Fish Comm. 4: 421-426.

Reeves, A.R., J. Choi, and J. Tremblay. 2011. Lobster Size at Maturity Estimates in Eastern Cape Breton, Nova Scotia.). DFO Can. Sci. Advis. Sec. Res. Doc. 2011/079.

Tremblay, M.J., C. MacDonald, and R. Claytor. 2009. Indicators of abundance and spatial distribution of lobsters (*Homarus americanus*) from standard traps. New Zeal. J. Mar. Freshwat. Res. 43(1): 387-399.

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.

Venning, W.H. 1873. Annual report of the Dept. of Marine and Fisheries. Append.N.

Wakeham, W. 1909. Evidence taken (re lobster fishery) pursuant to Order in Council June 21, 1909, Government of Canada.

7. APPENDICES

Appendix 1. At the framework meeting in February 2011, a summary table of the framework was developed. The following is an extract of the first two columns, together with whether the indicator is available in the current working paper (WP).

Indicator *LFA 27*	**Source of indicator**	**Available in Current WP?**
Fishery Performance		
Landings	LFA 27 Sales slips 47-1995	Yes
Landings	LFA 27Self reporting logs 1996-2006,	Yes
Landings	LFA 27 Mandatory logs	Yes
Commercial CPUE unstandardized	LFA 27 Mandatory logs	Yes
Commercial CPUE unstandardized	LFA 27 Voluntary logs	Yes
Commercial CPUE unstandardized	FSRS voluntary logs 27	No
Median size in landed catch	LFA 27 – port sampling	Yes
% in first molt group landed catch	LFA 27 – port sampling	Yes
Coefficient of variation (CV) around median length of port sample all LFAs	LFA 27 port sampling	Yes
Effort – trap hauls	LFA 27 – mandatory logs	Yes
Effort – days fished	LFA 27 – mandatory logs	Yes
Size of maturity –	LFA 27 pleopod cement gland staging (stage 2)	SEE framework WP, Reeves et al. (2011)
Abundance		
Sublegals in 27	LFA 27 FSRS recruitment traps	Yes
Commercial sizes-	LFA 27 FSRS recruitment	Yes
Berried females	LFA 27 FSRS recruitment traps	No
Berried females	Little river sea samples LFA 27	Yes
Berried females	Voluntary logs LFA 27,	Yes; [unstandardized)
Egg production index	LFA 27 Little River sea samples	Yes
Fishing pressure		
Exploitation rate CCIR	LFA 27 FSRS recruitment traps	Yes

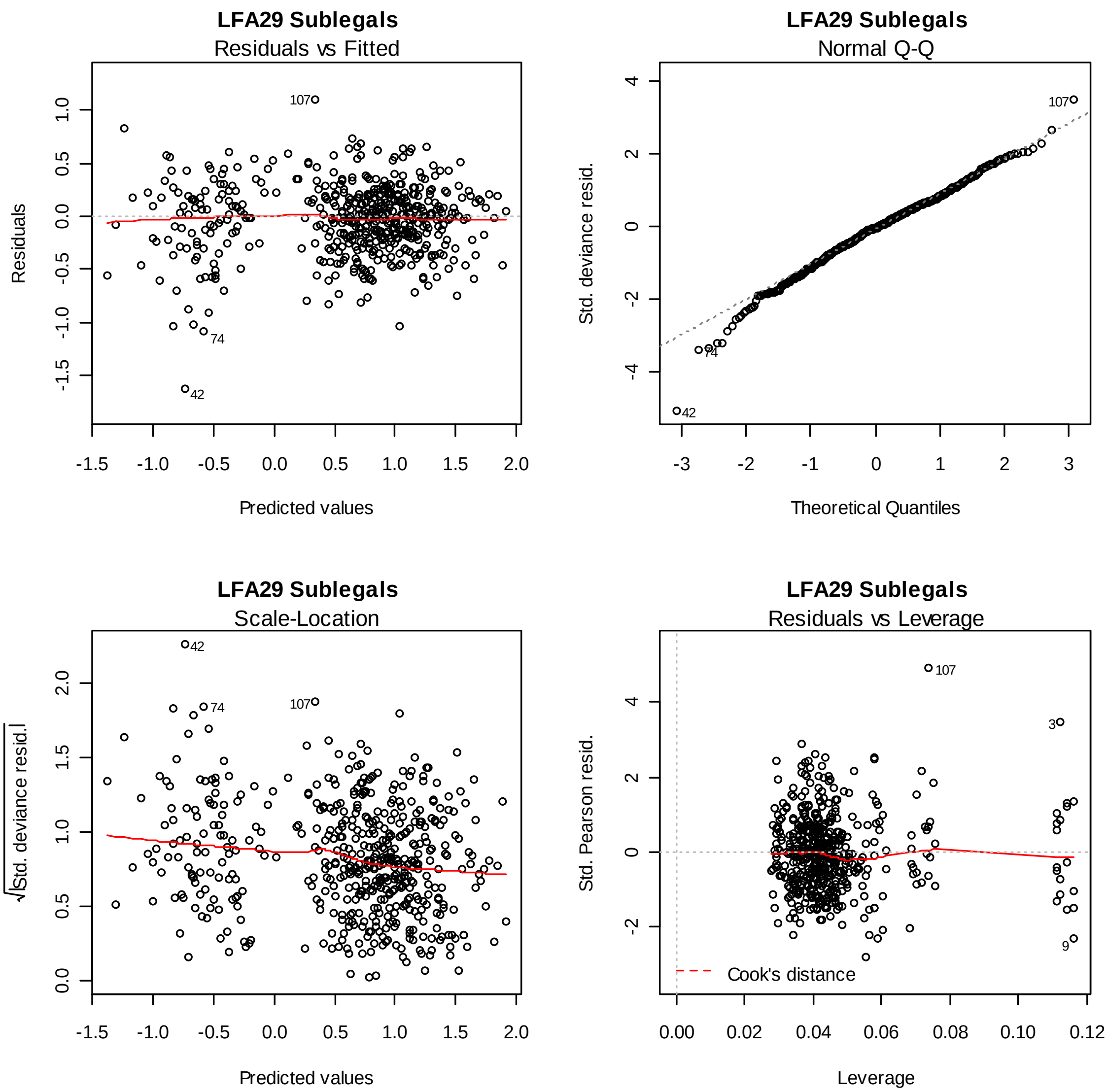
Appendix 1, continued.

Indicator *LFA 28-32*	**Source of indicator**	**Available in Current WP?**
Fishery Performance		
Landings	LFA 28-32 Sales slips 47-1995	Yes
Landings	LFA 28-32 Self reporting logs 1996-2006,	Yes
Landings	LFA 28-32 Mandatory logs	Yes
Commercial CPUE unstandardized	LFA 28-32 Mandatory logs	Yes
Commercial CPUE unstandardized	LFA 28-32 Voluntary logs	Yes [data for LFA 28, 29 insufficient]
Commercial CPUE unstandardized	FSRS voluntary logs LFA 28-32	No
Median size in landed catch	LFA 28-32 – port sampling	Yes
% in first molt group landed catch	LFA 28-32 – port sampling	Yes
CV around median of port sample all LFAs	LFA 28-32 – port sampling	Yes
Effort – trap hauls	LFA 28-32 – mandatory logs	Yes
Effort – days fished	LFA 28-32 – mandatory logs	Yes
Size of maturity –	LFA 29 mature cement glands (stage 2) size at 50% maturity	SEE framework WP, Reeves et al. (2011)
	LFA 31A – mature cement glands (stage 2),	Separate working paper: Silva et al.
Abundance		
Sublegals	LFA 28-32 FSRS recruitment traps	Yes
Sublegals relative to change in MLS	LFA 31A sea samples	-
Commercial	LFA 28-32 FSRS recruitment traps	Yes
Commercial	LFA 31A sea samples	Yes
Berried females	LFA 29-32 FSRS recruitment traps	No
Berried females	Voluntary logs LFA, 28-32	Yes [unstandardized]
Berried females	LFA 31A sea samples	Yes
Egg production index	LFA 31A	Yes
		Yes
Fishing pressure		
Exploitation rate CCIR	LFA 28-32 FSRS recruitment traps	Yes

Appendix 1, continued.

Indicator *LFA 33*	**Source of indicator**	**Available in Current WP?**
Fishery Performance		
Landings	LFA 33 Sales slips 47-1995	Yes
Landings	LFA 33Self reporting logs 1996-2006,	Yes
Landings	LFA 33 catch Mandatory logs	Yes
Commercial CPUE unstandardized	LFA 33 Mandatory logs	Yes
Commercial CPUE unstandardized	LFA 33 Voluntary logs	Yes
Commercial CPUE unstandardized	LFA 33 FSRS commercial traps	No
Commercial CPUE unstandardized	FSRS voluntary logs LFA 33	No
Median size in landed catch	LFA 33 – port sampling or sea sampling data	Yes
% in first molt group landed catch	LFA 33 – port sampling	Yes
CV around median of port sample all LFAs	LFA 33 – port sampling	Yes
Effort	LFA 33 – mandatory logs	Yes
Effort	Self reporting data LFA 33 – mandatory logs	
Size of maturity	LFA 33 mature cement glands (stage 2) size at 50% maturity	Separate working paper: Silva et al.
Abundance		
Sublegals – temperature corrected	LFA 33 FSRS recruitment traps + temperature	see Allard et al. 2012
Sublegals	LFA 33 FSRS recruitment traps	Yes
Legal	LFA 33 FSRS commercial traps	No
Legal -	LFA 33 FSRS recruitment traps	Yes
Berried females	LFA 33 FSRS commercial traps	No
Berried females	LFA 33 FSRS recruitment traps	No
Berried females	Voluntary logs LFA 33	Yes (unstandardized)
Egg production index	Not available for LFA 33	
Fishing pressure		
Exploitation rate CCIR	LFA 33 FSRS recruitment traps	Yes

Appendix 2. Diagnostic plots for GLM models for each of LFAs 29, 30, 31A, 31B, 32, 33 East, and 33 West. In each case the model included week of season, fishermen (fixed effect) and year.



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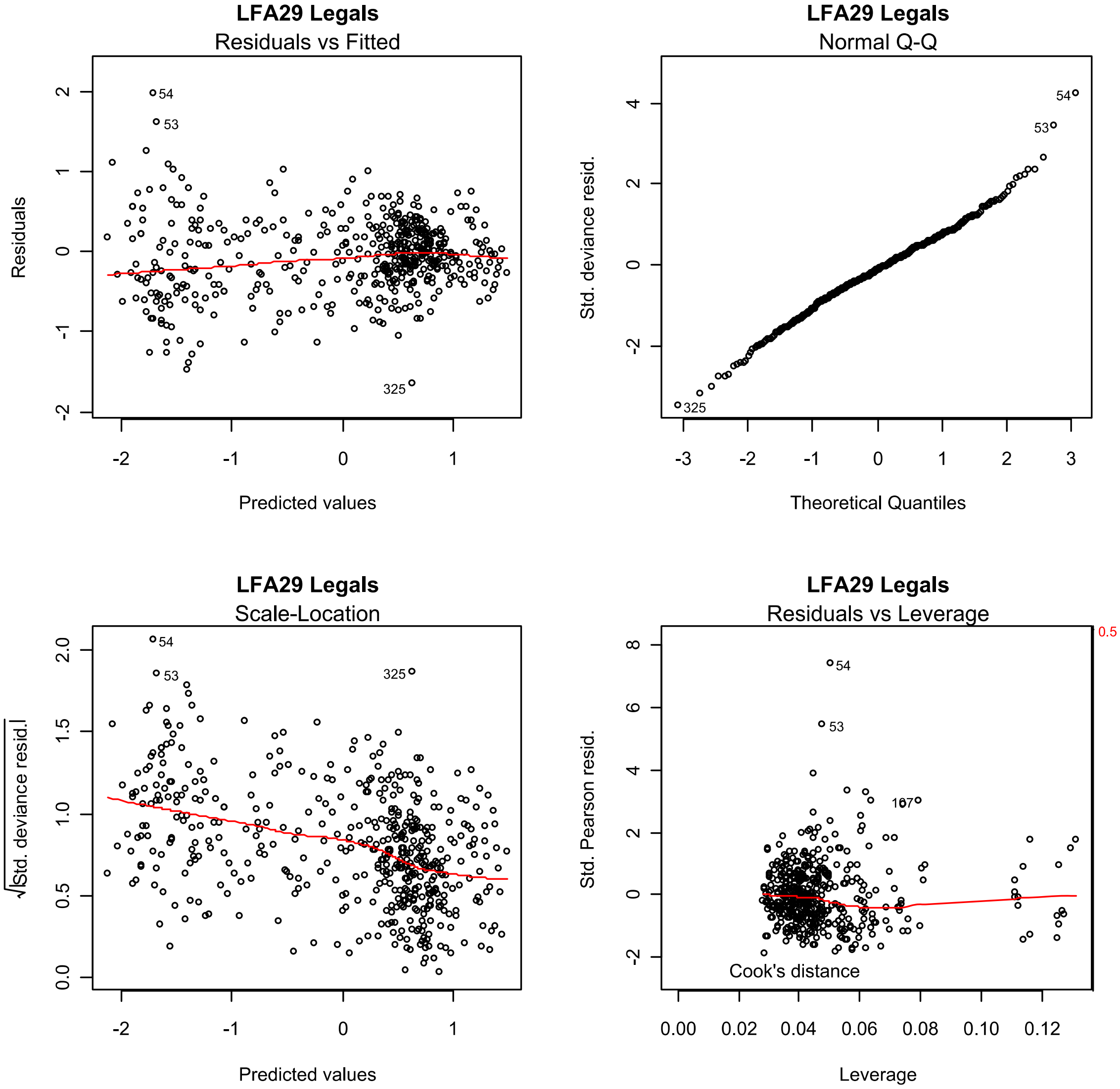

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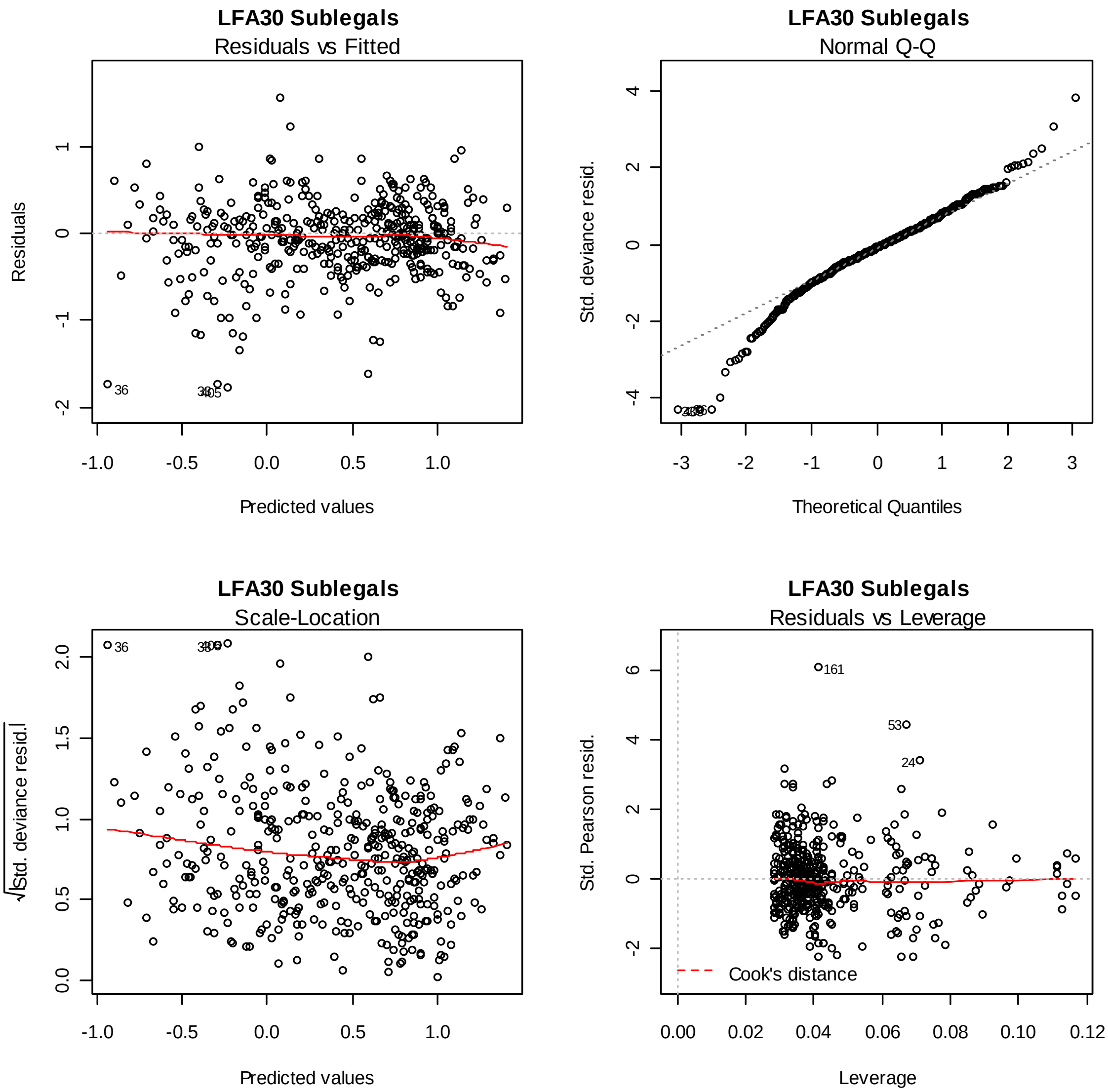

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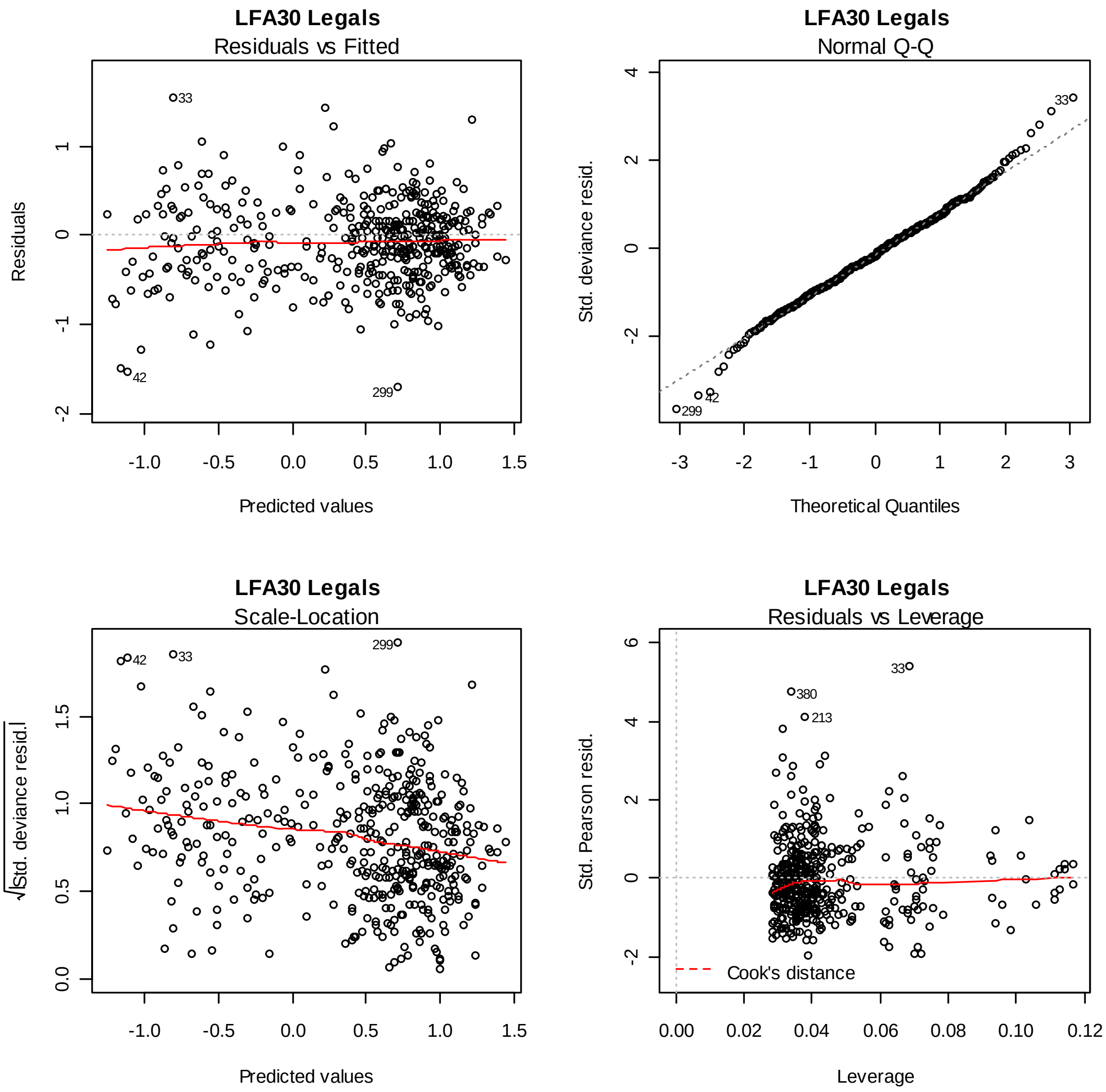

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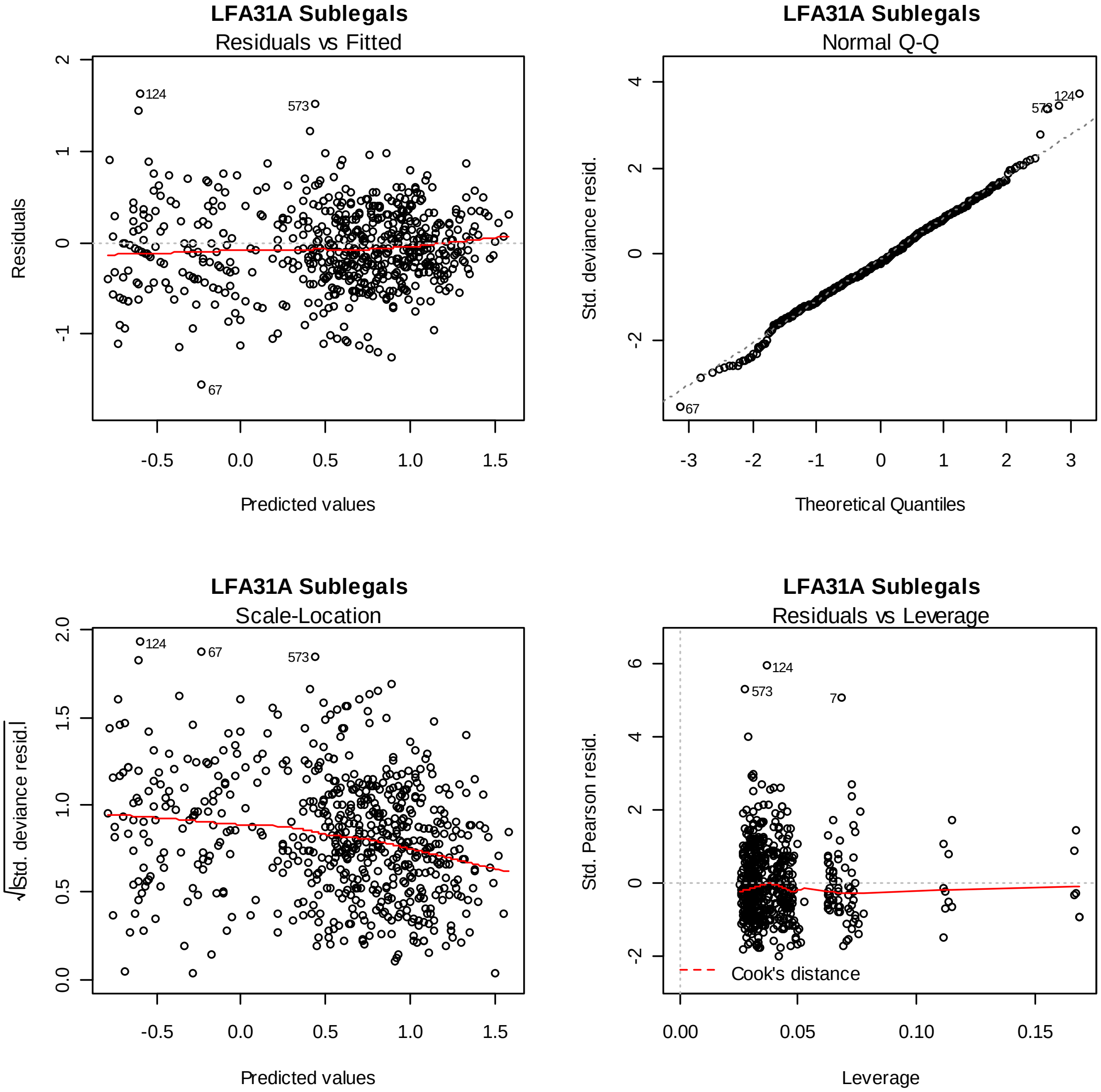

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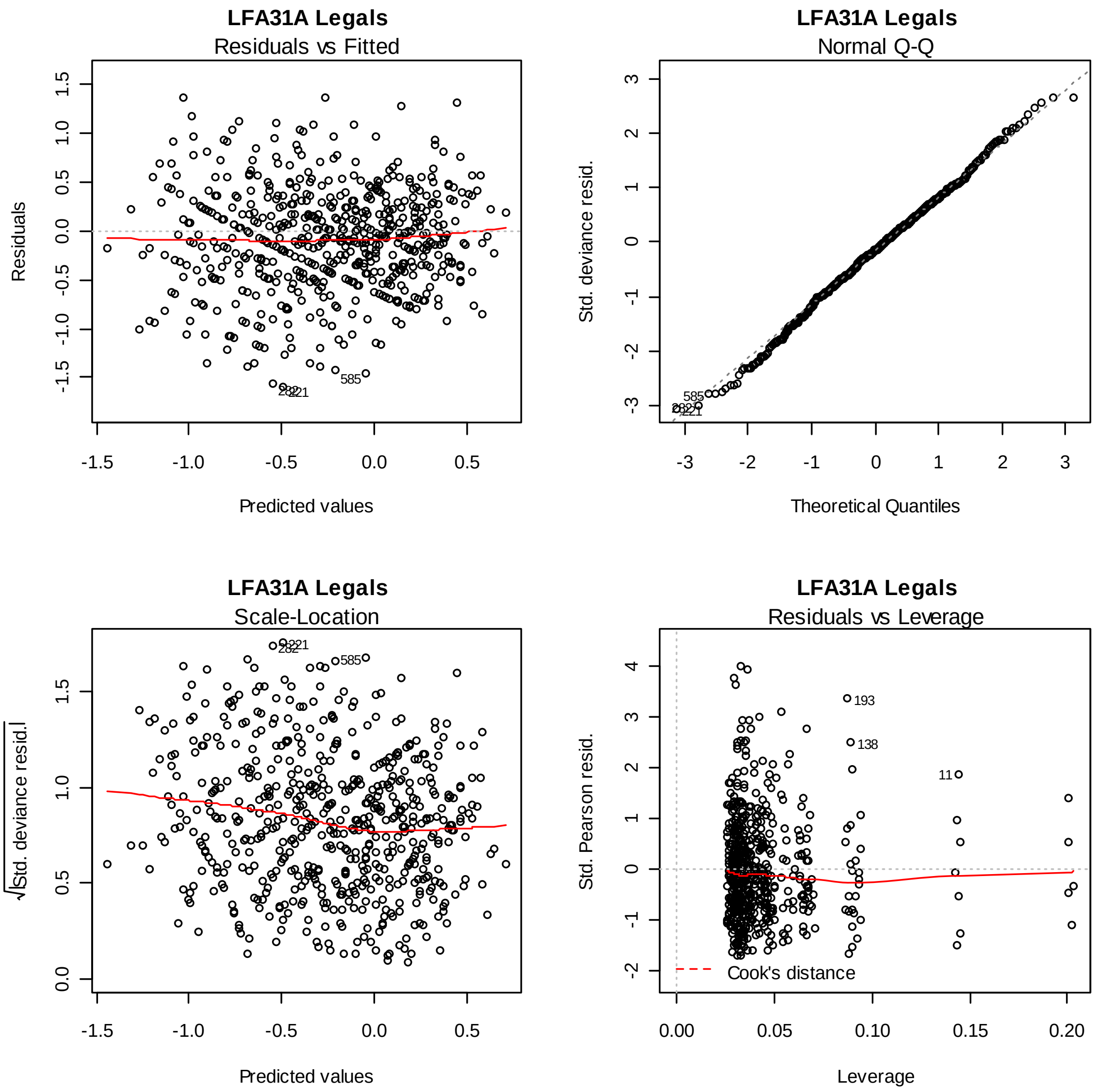

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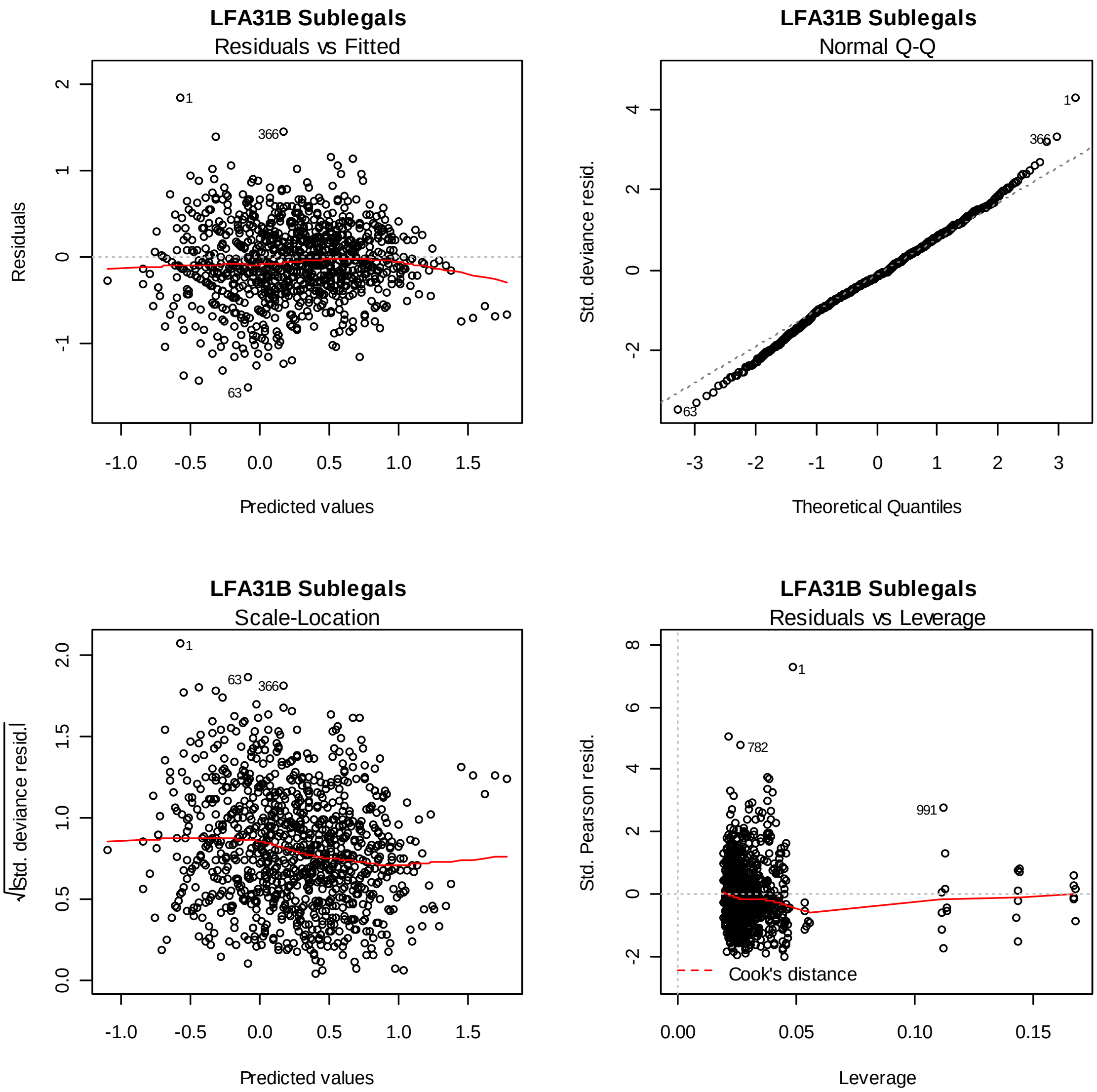

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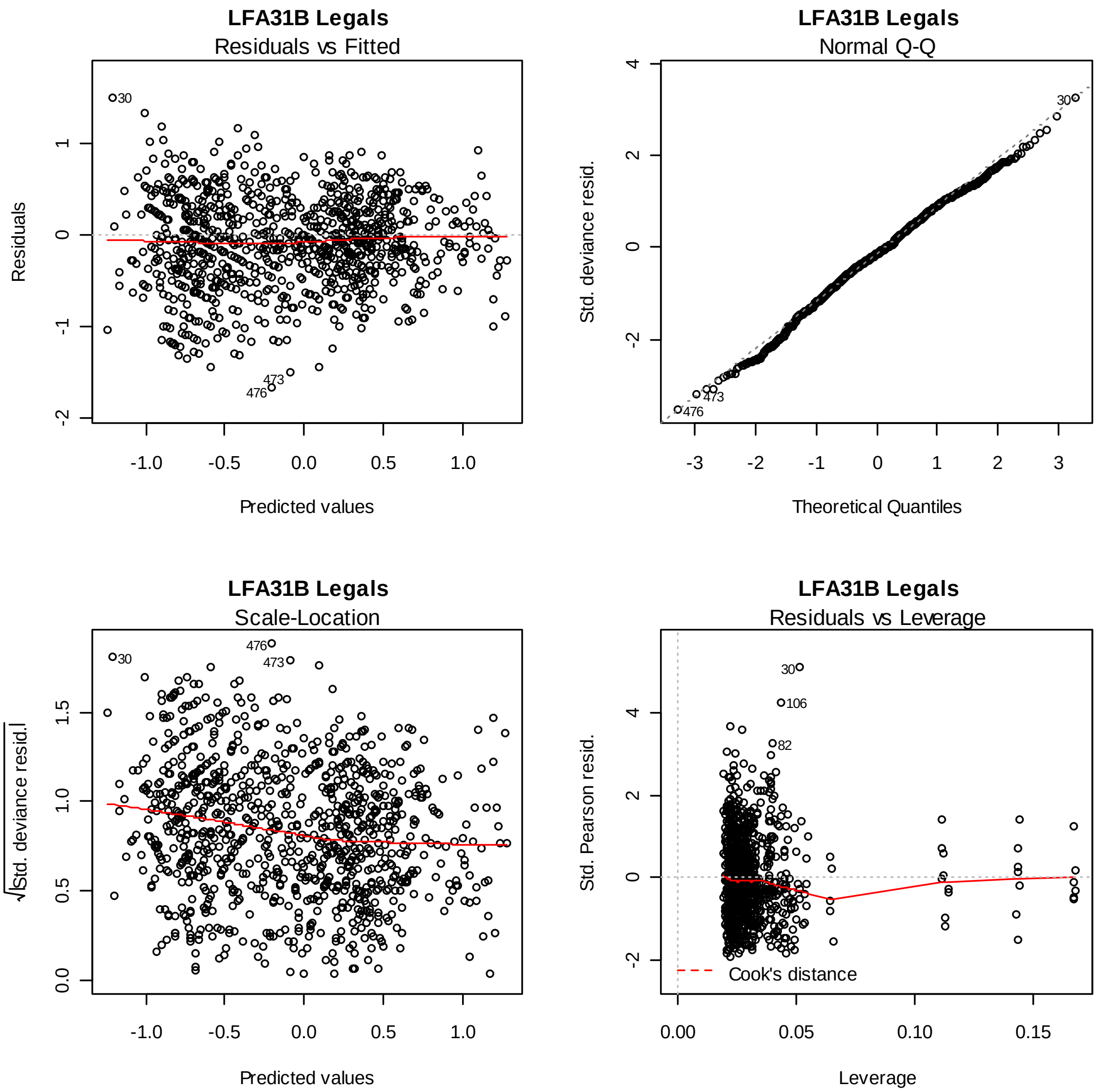

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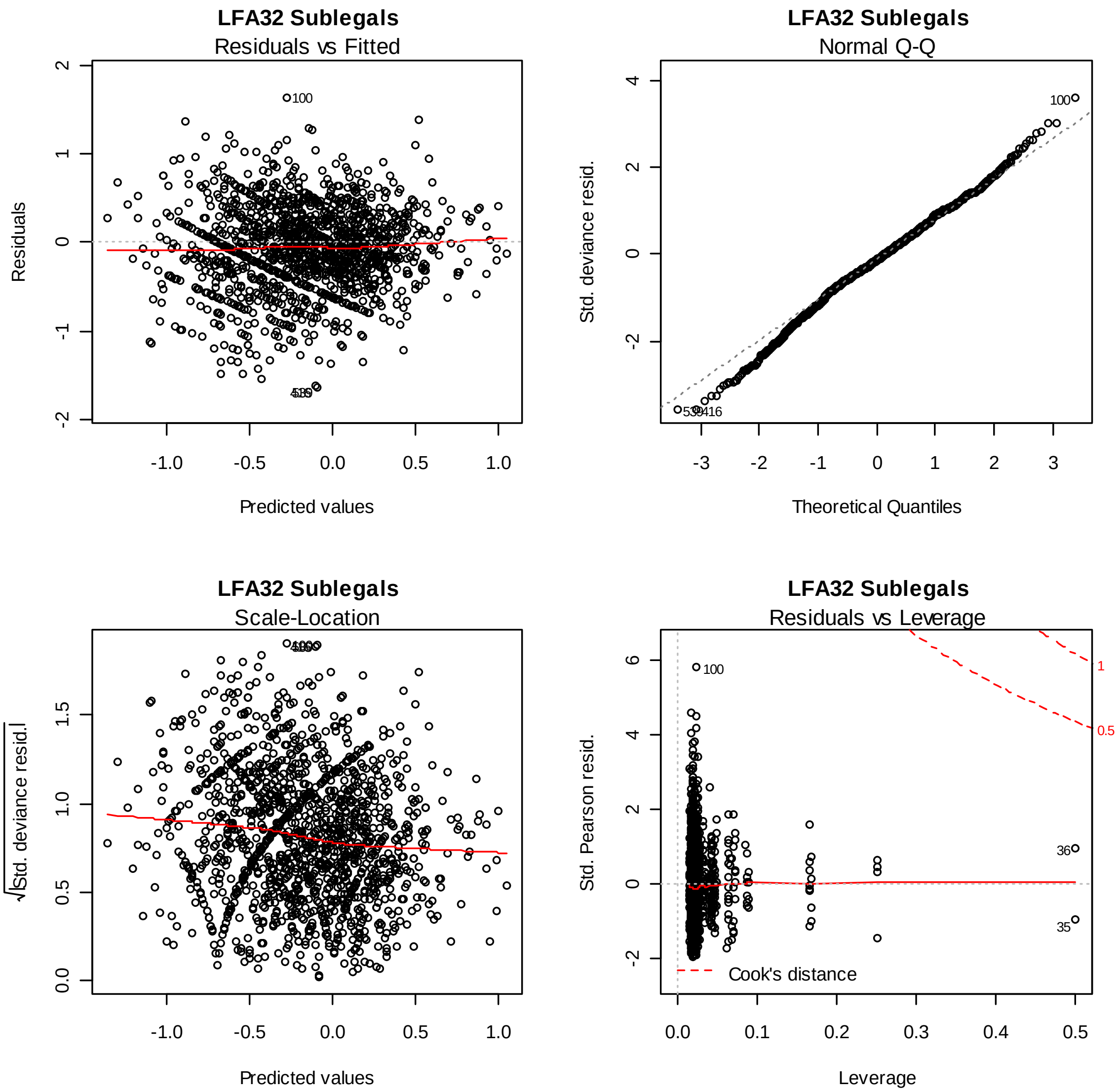

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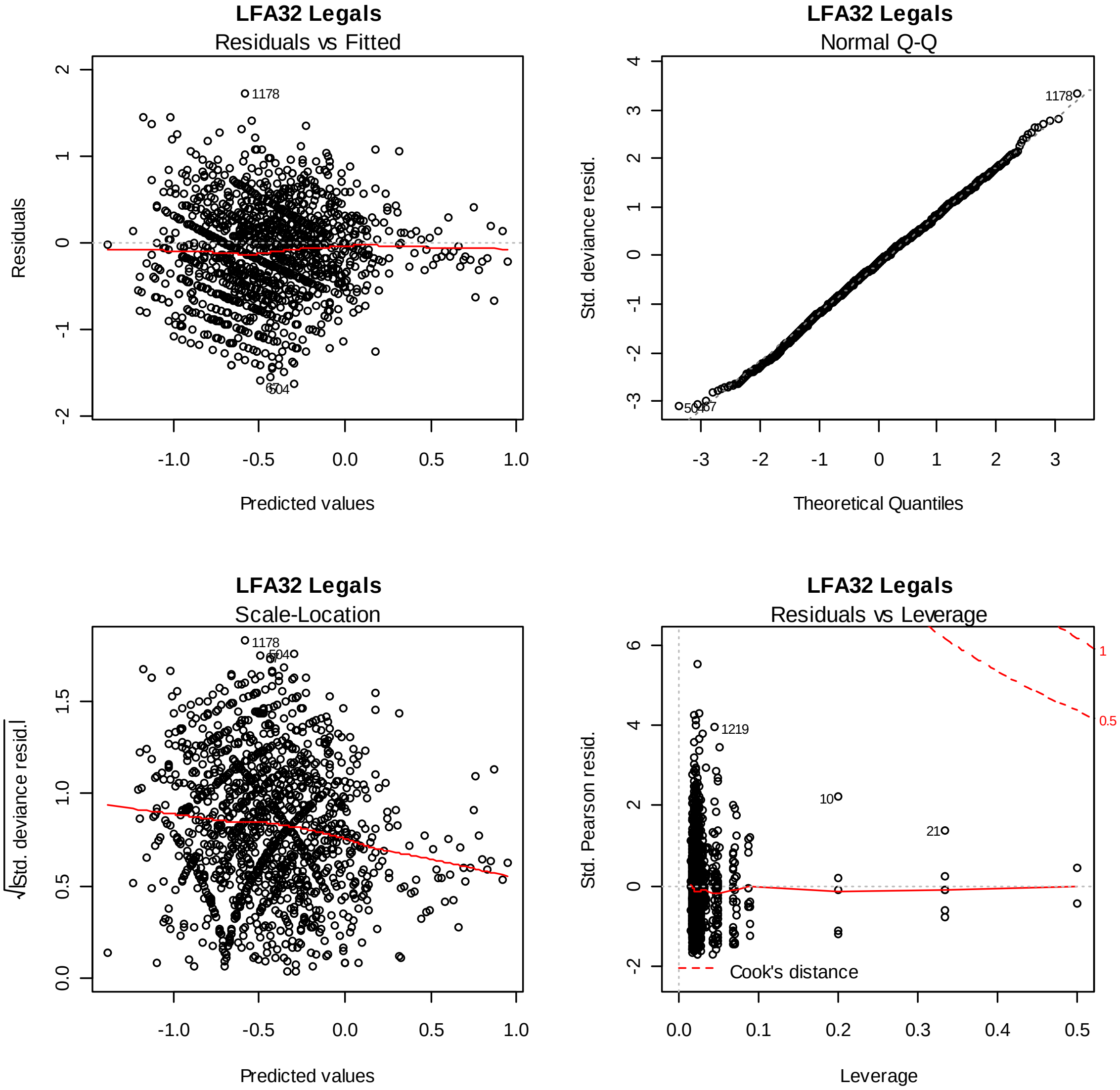

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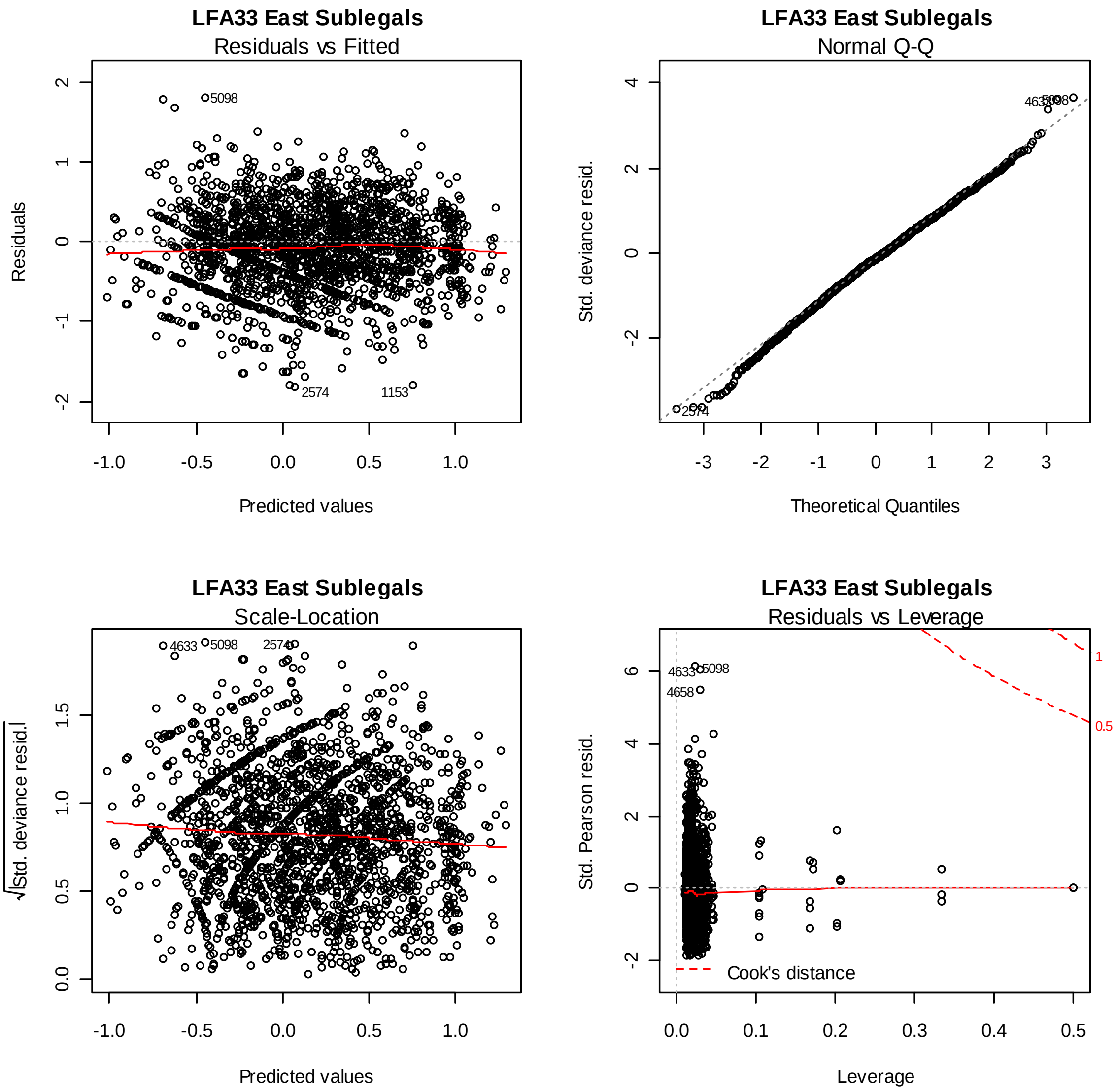

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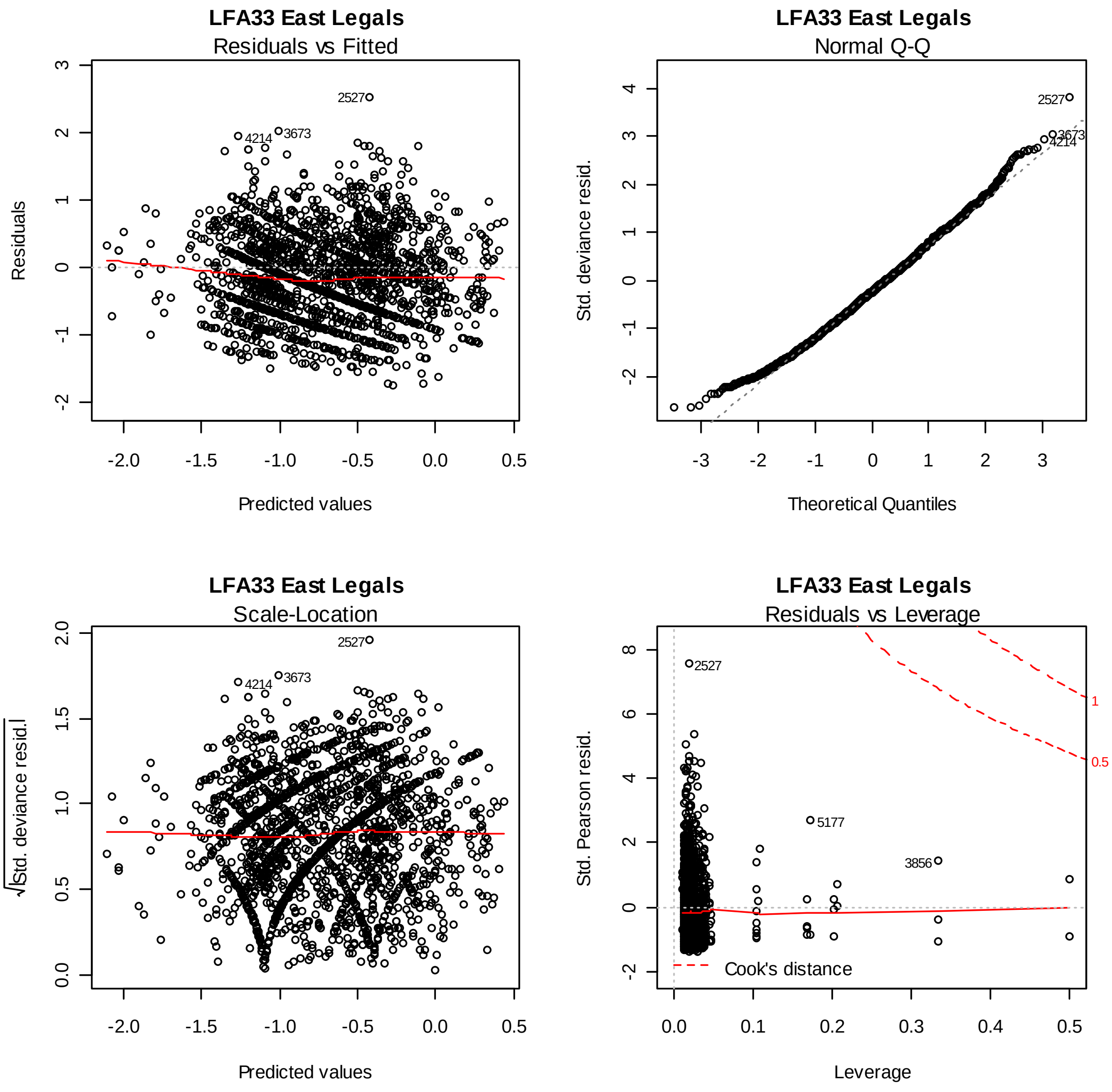

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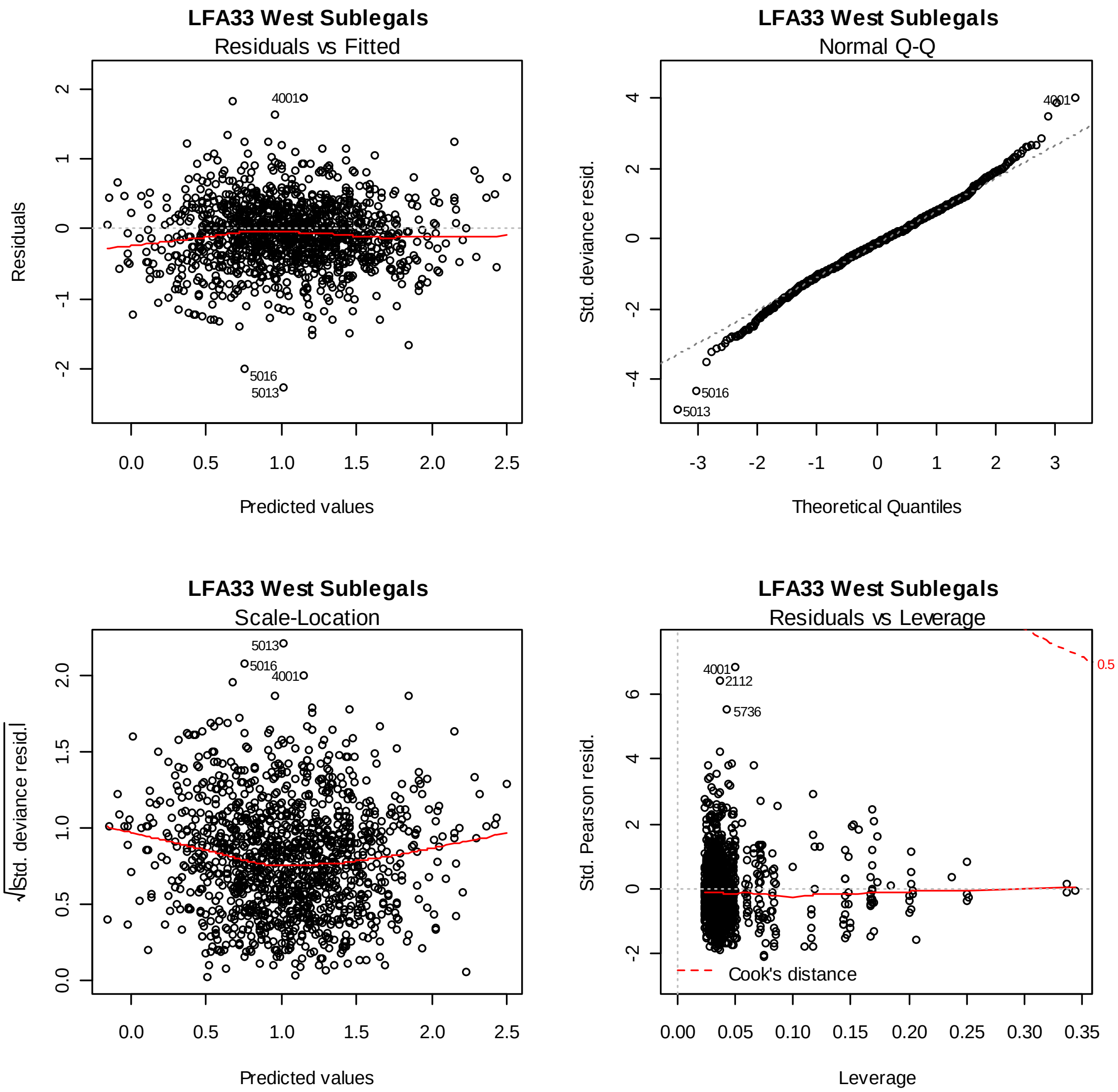

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