Underlying assumptions for the stock assessment of west coast rock lobster

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THE AREA-AGGREGATED MODEL

Population dynamics

The resource is assumed to be at equilibrium in 1870 when fishing is assumed to be initiated.

The model is a size-structured model on a 1mm scale.

Males and females are treated separately.

Discard mortality of 10% is assumed to operate on "discarded" lobsters.

The minimum legal carapace length has changed over time and is taken into account in the model.

The commercial catch is taken by two gear types (trap and hoopnets – the relative proportion of which has changed over the years).

Recreational catches and poaching are taken into account.

Male asymptotic natural survivorship is assumed to be 0.90. Female asymptotic natural survivorship is an estimable parameter, but is constrained to be ≤ 0.95.

Historic commercial Catch record

For the area-aggregated assessment:

1. The Roy Melville-Smith catch record (Melville-Smith and Van Sittert (2005)) is to be used for the period 1891-1967. A linear increase of zero catch in 1870 to the Melville-Smith value of 298 in 1891 is to be assumed.
2. The MCM database catch record is to be used for the period 1968-2004. This database provides catches for each area, and the values summed over all areas (1-14) will be used for the total catch record for 1968-2004.

Table 1 reports the area-aggregated as well as area-disaggregated catches used in the assessments.

Recreational Catch

The 1992-2000 values are estimated from telephone surveys (note though that the 1999 value is the average of the 1994-1998 values). The 2001 and 2002 estimates rest on the assumption that the recreational catch was 20% of the TAC calculated from the OMP for that season. For 2003-2005 it is assumed that the recreational take will be 320 MT. Further, it is assumed that recreational catch was zero in 1959, and that catches increased linearly to the estimated 1992 value. Table 2 reports the 1992-2002 values.

Poaching

The total poaching take is assumed to be as follows:

$$C_{p,t}^T = 0 \qquad t \leq 1949$$

$C_{p,t}^T$ increases linearly from zero in 1950 to 500 in 1990.

$$C_{p,t}^T = 500 \qquad t \geq 500$$

Somatic growth

A moult probability model (OLRAC(2005)) is used to produce a somatic growth rate for male lobsters for the period over which data are available (1968-2004). The average of these data are used for the pre-1968 period. A description of the somatic growth model used for females and for juveniles is found in RLWS/DEC05/ASS/7/1/2.

Assumptions for future projections

1) Future somatic growth

We use the average of available data i.e. the 1968-2004 average. For the work presented at this workshop on OMP development, the future somatic growth rate is taken to be the average of the 1989-2001 average. This assumption was made when developing the current OMP, and so this assumptions has been retained here for comparative purposes. The final choice of "future" somatic growth rate for the next OMP has yet to be made by the rock lobster Working Group.

2) Future recruitment

Replace R_{2002+} with the geometric mean of R_{75}, R_{80}, R_{85} and R_{95}. Assume linearity between R_{95} and R_{2000}.

3) Future trap:hoop ratio

The trend over recent years was examined and it is assumed that this trend will continue. This trap:hoop ratio is 85% trap.

4) Future recreational catch

Currently it is assumed that 10% of the global TAC will be "allocated" to the recreational sector. However, this is under policy revision at present, and the outcome thereof would be accommodated here.

5) Future levels of poaching
We assume the current estimated levels remain constant, i.e.
A1-2: 0 MT
A3-6: 25 MT
A7:   75 MT
A8:   400 MT

THE AREA-DISAGGREAGATED MODELS

Introduction

The West Coast resource is divided into the following "super" areas:
Area 1-2: The most Northern region – only a very small tonnage is currently caught in this area.
Area 3-6 (covers Areas 3, 4, 5 and 6), this is further broken down into:
        Area 3-4 (Areas 3 and 4 only)
        Area 5-6 (Areas 5 and 6 only)
Area 7 (Dassen Island), and
Area 8+ (areas to the south and east of Dassen Island, which include Area 8 (Cape Point), Area 10 (Hout Bay), Area 11 (False Bay), and Areas 12-14 (East of Hangklip).

Figure 1 illustrates the West Coast rock lobster fishing zones and areas.

Various methods have been used to collate data from Areas 3, 4, 5 and 6 to produce values for the "super" Area 3-6.

Note that the convention used here for referring to split seasons is to quote only the first of the two years for each split season, i.e. the 1992/93 season is referred to here as "1992".

A similar modelling approach is taken for each super-area as taken for the area-aggregated model, i.e. starts in 1870; size-structured etc.

The area-disaggregated modelling approach assumes that recruitment from each area remains in that area and that there is no immigration or emigration between areas (of larvae or adults).

Historic Catch Record

For the area-disaggregated assessments:

The Roy Melville-Smith catch record (i.e. pre-1968 period) is to be split for the different areas as follows:

$$C_{c,t}^{1-2} = 0.20 * C_{c,t}^{T}$$

$$C_{c,t}^{3-6} = 0.50 * C_{c,t}^{T}$$

$$C_{c,t}^{7} = 0.20 * C_{c,t}^{T}$$

$$C_{c,t}^{8} = 0.10 * C_{c,t}^{T}$$

where $C_{c,t}^{T}$ is the total commercial (Melville-Smith) catch for season t. When A3-6 is further divided into A3-4 and A5-6, a 40:60 split of the A3-6 catches is assumed for these two regions respectively. Figure 2 shows the MCM reported catches (expressed as % of the total west coast catch) for each "super-area" (1968+) upon which the above "historic" divisions were based upon, in conjunction with the knowledge that there has been a "fishing-down" of the resource from the North to the South over time.

The MCM database catch record is to be used for the period 1968-2004. This database provides commercial catches for each area.

Recreational catch data

Estimates, based upon telephone surveys, of the percentage breakdown for the "super" areas of the total annual recreational catches are as follows:

Area 1-2: 0 %
Area 3-6: 15% [this is further split equally into Area 3-4 and Area 5-6]
Area 7: 5%
Area 8: 80%

Poaching

The total poaching take from the resource is assumed to be divided into the super-areas as follows:

Area 1-2:   0%
Area 3-6:   5% [this is further split equally into Area 3-4 and Area 5-6]
Area 7:   15%
Area 8+:   80%

Somatic Growth rate

Somatic growth data used in these assessments are from the updated moult probability model (see OLRAC (2005)) which provides a somatic growth series for each of the "super" areas for the 1968-2004 period.

Note that for super-area A1-2 future somatic growth, the 1985-2004 average is used (the somatic growth series for this region starts only in 1985).

Assumptions for future projections

1) Future somatic growth

We use the average of available data.

For super-areas A3-6, A7 and A8: for 2005+ - use the 1968-2004 average.

For super-area A1-2: for 2005+ - use the 1985-2004 average (the somatic growth series for this area only starts in 1985).

For work presented at this workshop by the authors on initial OMP development, the future somatic growth rate is assumed to be the average of the 1989-2001 average for comparability to previous OMPs.

2) Future recruitment

For all four super-areas: Replace R_{2002+} with the geometric mean of R_{75}, R_{80}, R_{85} and R_{95}. Assume linearity between R_{95} and R_{2000}.

3) Future trap:hoop ratio

The trends for each area were examined over recent years and the following ratios are suggested for the reference case models:

A1-2: 0% trap

A3-6: 10% trap

A7: 100% trap

A8: 85% trap

4) Future recreational catch

Although we assume this comes out of the "global" TAC that we will project ahead with or the RYs we will calculate, we will apportion the following to recreational catches. What was done was to calculate the proportion of recreational take to recreational+commercial catch we have for each area. The average over 1998-2002 period was calculated. The following are thus the proportions of the "global" TAC (for each area) which is assumed goes to recreationals.

A1-2: 0.00

A3-6, A3-4 and A5-6: 0.32

A7: 0.03

A8: 0.22

IE we assume 22% of the global TAC in super-area 8 will go to recreationals and 78% to commercial catch.

5) Future levels of poaching

We assume the current estimated levels remain constant, i.e.

Area 1-2: 0 MT

Area 3-6: 25 MT [Area 34 and Area 5-6 = 12.5 each]

Area 7: 75 MT

Area 8: 400 MT

Other data
Data available for each assessment include:
   a) Trap and hoopnet CPUE data
   b) FIMS CPUE data
   c) Trap and hoopnet catch-at-size data (males and females separately). Appendix 1 describes how the data from individual area are combined for the Area 3-6, Area 3-4 and Area 3-5 series.
   d) FIMS catch-at-size data (males and females separately)
   e) F% (percentage females by number in the catch) for trap, hoopnet and FIMS.
Note:
   i)   For Area 8 and for the area-aggregated assessment, there is also sub-legal commercial catch-at-size data available for 1994-1998.
   ii)   There are only hoopnet data available for A1-2 (no trap or FIMS).
   iii) There are no FIMS data available for A5-6.

Replacement Yield Calculations

For each super-area, and for RC1 and RC2, we can calculate the RY over the next 10 years so that $B75(2016)=B75(2006)$. We thus project ahead with a constant catch for years 2006…2015 (a 10 year period), then work out the biomass at the end of that period ($B75(2016)$).

Table 1: Commercial catch record used for west coast rock lobster assessments.

	area-aggregated model	Area 1-2	Area 3-4	Area 5-6	Area 7	Area 8
1870	0.00	0.00	0.00	0.00	0.00	0.00
1871	14.19	2.84	2.84	4.26	2.84	1.42
1872	28.38	5.68	5.68	8.51	5.68	2.84
1873	42.57	8.51	8.51	12.77	8.51	4.26
1874	56.76	11.35	11.35	17.03	11.35	5.68
1875	70.95	14.19	14.19	21.29	14.19	7.10
1876	85.14	17.03	17.03	25.54	17.03	8.51
1877	99.33	19.87	19.87	29.80	19.87	9.93
1878	113.52	22.70	22.70	34.06	22.70	11.35
1879	127.71	25.54	25.54	38.31	25.54	12.77
1880	141.90	28.38	28.38	42.57	28.38	14.19
1881	156.10	31.22	31.22	46.83	31.22	15.61
1882	170.29	34.06	34.06	51.09	34.06	17.03
1883	184.48	36.90	36.90	55.34	36.90	18.45
1884	198.67	39.73	39.73	59.60	39.73	19.87
1885	212.86	42.57	42.57	63.86	42.57	21.29
1886	227.05	45.41	45.41	68.11	45.41	22.70
1887	241.24	48.25	48.25	72.37	48.25	24.12
1888	255.43	51.09	51.09	76.63	51.09	25.54
1889	269.62	53.92	53.92	80.89	53.92	26.96
1890	283.81	56.76	56.76	85.14	56.76	28.38
1891	298.00	59.60	59.60	89.40	59.60	29.80
1892	262.00	52.40	52.40	78.60	52.40	26.20
1893	1279.00	255.80	255.80	383.70	255.80	127.90
1894	894.00	178.80	178.80	268.20	178.80	89.40
1895	710.00	142.00	142.00	213.00	142.00	71.00
1896	1492.00	298.40	298.40	447.60	298.40	149.20
1897	727.00	145.40	145.40	218.10	145.40	72.70
1898	762.00	152.40	152.40	228.60	152.40	76.20
1899	757.00	151.40	151.40	227.10	151.40	75.70
1900	892.00	178.40	178.40	267.60	178.40	89.20
1901	844.00	168.80	168.80	253.20	168.80	84.40
1902	445.00	89.00	89.00	133.50	89.00	44.50
1903	95.00	19.00	19.00	28.50	19.00	9.50
1904	225.00	45.00	45.00	67.50	45.00	22.50
1905	404.00	80.80	80.80	121.20	80.80	40.40
1906	206.00	41.20	41.20	61.80	41.20	20.60
1907	504.00	100.80	100.80	151.20	100.80	50.40
1908	943.00	188.60	188.60	282.90	188.60	94.30
1909	1645.00	329.00	329.00	493.50	329.00	164.50
1910	1552.00	310.40	310.40	465.60	310.40	155.20
1911	2255.00	451.00	451.00	676.50	451.00	225.50
1912	4274.00	854.80	854.80	1282.20	854.80	427.40
1913	5546.00	1109.20	1109.20	1663.80	1109.20	554.60
1914	5666.00	1133.20	1133.20	1699.80	1133.20	566.60
1915	7329.00	1465.80	1465.80	2198.70	1465.80	732.90
1916	7096.00	1419.20	1419.20	2128.80	1419.20	709.60
1917	7851.00	1570.20	1570.20	2355.30	1570.20	785.10
1918	4543.00	908.60	908.60	1362.90	908.60	454.30

1919	7185.00	1437.00	1437.00	2155.50	1437.00	718.50
1920	6774.00	1354.80	1354.80	2032.20	1354.80	677.40
1921	5353.00	1070.60	1070.60	1605.90	1070.60	535.30
1922	7510.00	1502.00	1502.00	2253.00	1502.00	751.00
1923	5654.00	1130.80	1130.80	1696.20	1130.80	565.40
1924	6726.00	1345.20	1345.20	2017.80	1345.20	672.60
1925	8092.00	1618.40	1618.40	2427.60	1618.40	809.20
1926	6175.00	1235.00	1235.00	1852.50	1235.00	617.50
1927	6433.00	1286.60	1286.60	1929.90	1286.60	643.30
1928	7836.00	1567.20	1567.20	2350.80	1567.20	783.60
1929	7960.00	1592.00	1592.00	2388.00	1592.00	796.00
1930	8767.00	1753.40	1753.40	2630.10	1753.40	876.70
1931	8197.00	1639.40	1639.40	2459.10	1639.40	819.70
1932	11298.00	2259.60	2259.60	3389.40	2259.60	1129.80
1933	13290.00	2658.00	2658.00	3987.00	2658.00	1329.00
1934	6538.00	1307.60	1307.60	1961.40	1307.60	653.80
1935	6746.00	1349.20	1349.20	2023.80	1349.20	674.60
1936	9211.00	1842.20	1842.20	2763.30	1842.20	921.10
1937	10184.00	2036.80	2036.80	3055.20	2036.80	1018.40
1938	8946.00	1789.20	1789.20	2683.80	1789.20	894.60
1939	9933.00	1986.60	1986.60	2979.90	1986.60	993.30
1940	10157.00	2031.40	2031.40	3047.10	2031.40	1015.70
1941	9714.00	1942.80	1942.80	2914.20	1942.80	971.40
1942	7698.00	1539.60	1539.60	2309.40	1539.60	769.80
1943	4560.00	912.00	912.00	1368.00	912.00	456.00
1944	3279.00	655.80	655.80	983.70	655.80	327.90
1945	4904.00	980.80	980.80	1471.20	980.80	490.40
1946	8631.00	1726.20	1726.20	2589.30	1726.20	863.10
1947	10841.00	2168.20	2168.20	3252.30	2168.20	1084.10
1948	11491.00	2298.20	2298.20	3447.30	2298.20	1149.10
1949	11009.00	2201.80	2201.80	3302.70	2201.80	1100.90
1950	16274.00	3254.80	3254.80	4882.20	3254.80	1627.40
1951	16752.00	3350.40	3350.40	5025.60	3350.40	1675.20
1952	13103.00	2620.60	2620.60	3930.90	2620.60	1310.30
1953	12294.00	2458.80	2458.80	3688.20	2458.80	1229.40
1954	11133.00	2226.60	2226.60	3339.90	2226.60	1113.30
1955	10847.00	2169.40	2169.40	3254.10	2169.40	1084.70
1956	10805.00	2161.00	2161.00	3241.50	2161.00	1080.50
1957	8981.00	1796.20	1796.20	2694.30	1796.20	898.10
1958	8245.00	1649.00	1649.00	2473.50	1649.00	824.50
1959	10543.00	2108.60	2108.60	3162.90	2108.60	1054.30
1960	10317.00	2063.40	2063.40	3095.10	2063.40	1031.70
1961	10360.00	2072.00	2072.00	3108.00	2072.00	1036.00
1962	10064.00	2012.80	2012.80	3019.20	2012.80	1006.40
1963	10412.00	2082.40	2082.40	3123.60	2082.40	1041.20
1964	10407.00	2081.40	2081.40	3122.10	2081.40	1040.70
1965	10218.00	2043.60	2043.60	3065.40	2043.60	1021.80
1966	9022.00	1804.40	1804.40	2706.60	1804.40	902.20
1967	7054.00	1410.80	1410.80	2116.20	1410.80	705.40
1968	4065.00	1126.00	1178.00	707.00	640.00	414.00
1969	4220.00	465.00	1212.00	866.00	946.00	731.00
1970	4274.00	61.00	1847.00	879.00	826.00	661.00
1971	4104.00	278.00	1109.00	1369.00	918.00	430.00
1972	4475.00	348.00	1292.00	1272.00	935.00	628.00

1973	4406.00	338.00	1403.00	702.00	1200.00	763.00
1974	4701.00	83.00	1939.00	846.00	873.00	960.00
1975	5140.00	172.00	1983.00	1107.00	925.00	953.00
1976	5584.00	198.00	1248.00	1691.00	1344.00	1103.00
1977	5907.00	28.00	597.00	2072.00	2115.00	1095.00
1978	4978.00	48.00	737.00	2169.00	1480.00	544.00
1979	4734.00	27.00	401.00	2166.00	1360.00	780.00
1980	4474.00	39.00	949.00	1819.00	781.00	886.00
1981	3683.00	49.00	893.00	1523.00	645.00	573.00
1982	3701.00	61.00	1010.00	1377.00	753.00	500.00
1983	3716.00	65.00	1113.00	1184.00	833.00	521.00
1984	3728.00	44.00	1079.00	1195.00	900.00	510.00
1985	3796.00	96.00	997.00	1140.00	1029.00	534.00
1986	4000.00	68.00	1008.00	1096.00	1220.00	608.00
1987	3834.00	115.00	1045.00	1079.00	958.00	637.00
1988	4000.00	100.00	1110.00	1056.00	1023.00	711.00
1989	3491.00	92.00	827.00	763.00	1086.00	723.00
1990	2996.00	39.00	510.00	686.00	716.00	1045.00
1991	2480.00	31.00	512.00	607.00	504.00	826.00
1992	2176.40	46.00	541.00	488.00	378.00	723.40
1993	2197.00	39.00	555.00	370.00	342.00	891.00
1994	1966.00	27.00	502.00	130.00	315.00	992.00
1995	1516.00	30.00	373.00	54.00	266.00	793.00
1996	1674.00	30.00	387.00	37.00	318.00	902.00
1997	1918.40	27.00	152.40	50.00	663.00	1026.00
1998	1792.00	9.00	109.00	14.00	578.00	1082.00
1999	2315.00	6.00	148.00	14.00	1046.40	1100.60
2000	1609.00	13.00	97.00	11.00	583.00	905.00
2001	2073.00	11.00	126.00	25.00	711.00	1200.00
2002	2462.00	20.00	77.00	43.00	998.00	1324.00
2003	2918.00	25.00	110.00	29.00	1057.00	1697.00
2004	3205.00	27.00	121.00	31.00	1163.00	1863.00
2005	2875.30	30.00	108.00	40.50	969.30	1727.50

Table 2: Recreational catch estimates for the area-aggregated model.

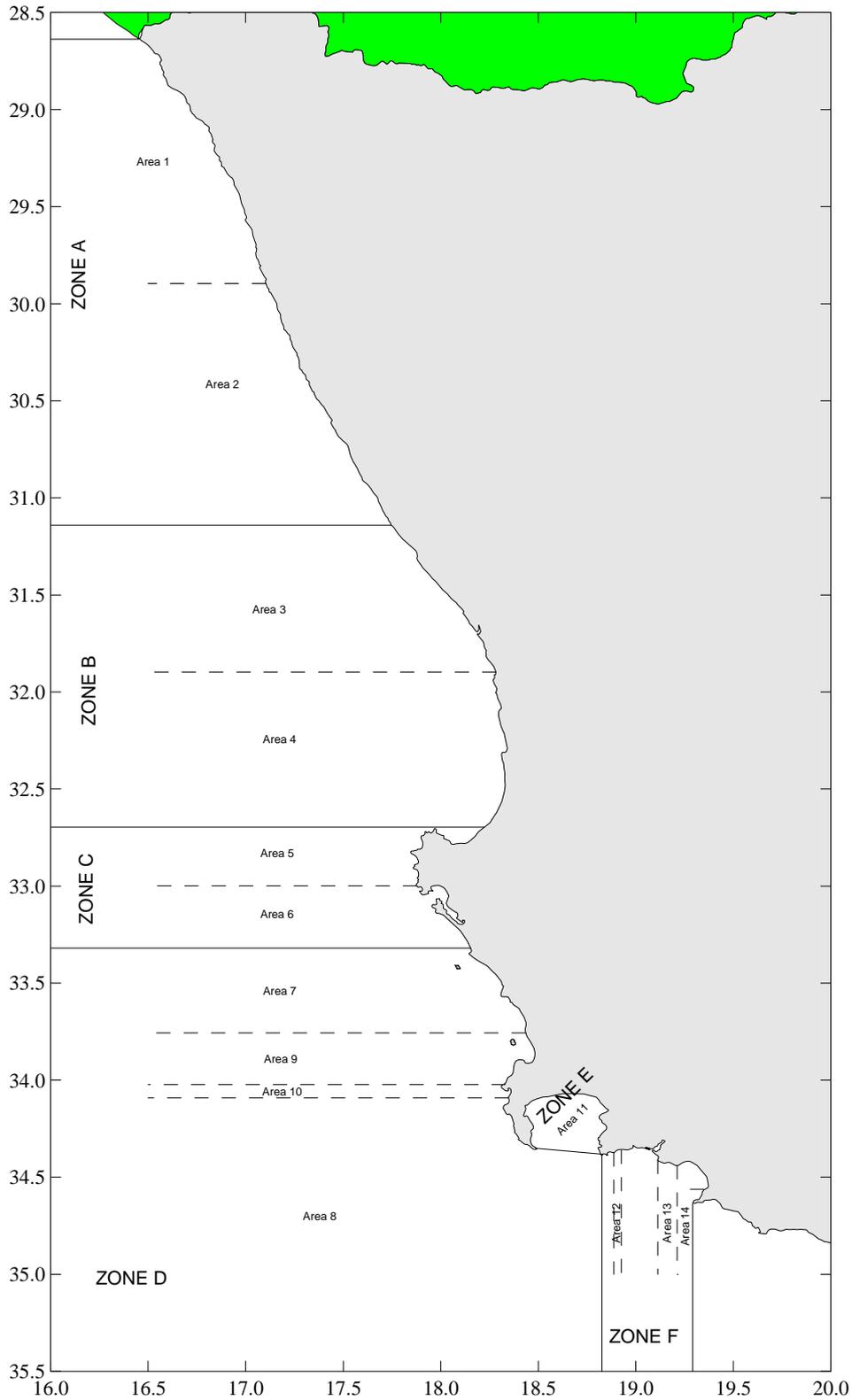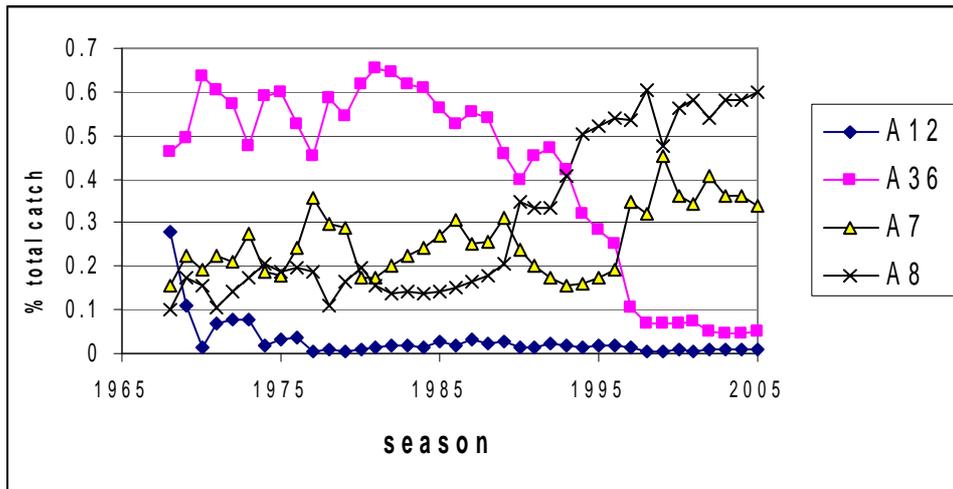| Season	Recreational catch (MT)
1992	469
1993	391
1994	336
1995	379
1996	496
1997	340
1998	249
1999	360
2000	404
2001	468
2002	583

Figure 1: West coast rock lobster fishing zones and areas.

Figure 2: Super-area percentage breakdown of the total west coast catch.

Appendix 1: The pseudo weighting method for calculating the commercial catch size structure for Area 3-6.

A pseudo-weighting technique is used to weight the data from each of the four Areas that form the "super" Area 3-6, to produce a catch-at-size frequency for Area 3-6. The aim of this weighting scheme is to maintain the total sample size for each year, but weight the individual Area data according to each Area's commercial catch contribution that year. The $p_{l,t}^{s}$ values (effectively the catch-at-size proportion for length l, in year t for either sex s) are calculated as follows:

$$p_{l,t}^{s} = \frac{\displaystyle\sum_{a}\left[n_{l,a,t}^{s} \frac{C_{a,t}}{\displaystyle\sum_{a} C_{a,t}} \right]}{\displaystyle\sum_{a,l}\left[n_{l,a,t}^{s} \frac{C_{a,t}}{\displaystyle\sum_{a} C_{a,t}} \right]}$$

where

a - refers to the Area 3, 4, 5 or 6,

$C_{a,t}$ - refers to the catch in Area a in year t,

$n_{l,a,t}^{s}$ - is the sample catch-at-size number for length l in year t in Area a (for sex s),
   and

$p_{l,t}^{s}$ - is the catch-at-size proportion for length l and time t for sex s.