RESULTS

Seagrass Species

Six species of seagrasses (from two families) were identified in the survey area.

Seagrass taxa	Nov 1995	Dec 1997	Nov 1998	Dec 1999
Family *Hydrocharitaceae Jussieu*				
Halophila ovalis (Br.) D.J. Hook	✓	✓	✓	✓
Halophila decipiens Ostenfeld	✓	✓	✓	✓
Halophila spinulosa (R.Br.) Aschers. In Neumayer	✓	✓	✓	✓
Halophila tricostata Greenway	✓			
Family Cymodoceaceae Taylor				
Halodule uninervis (wide & narrow leaf)(Forsk.) Aschers*	✓	✓	✓	✓
Halodule pinifolia (Miki) den Hartog*	✓	✓	✓	✓

* *Halodule uninervis* (narrow leaf) and *Halodule pinifolia* are very similar in morphology and are difficult to distinguish underwater. Recent studies from the Queensland east coast suggest there are no genetic distinctions between the two currently recognised species (M. Waycott. Pers. Comm.). In this study (1995-1999) they have been combined and the data pooled for analyses.

Seagrass Distribution

The total area of seagrass habitat mapped in the monitoring region in December 1999 (312 ±14 ha) was greater than in all previous surveys (Table 1, Map 2).

Halophila ovalis was the most common species at Oyster Point and present in approximately 85% of the total area of seagrass mapped in December 1999 – similar to November 1998 (89%) and slightly greater than in December 1997 (75%) and November 1995 (70%) (Table 1, Map 5). There were two distinct zones of seagrass which persisted between years: a near-shore intertidal band dominated by *Halodule pinifolia/uninervis* (narrow) and a sub-tidal band dominated by *Halophila ovalis*, with some *Halophila decipiens* (Maps 3 to 5). *Halophila spinulosa*, *Halophila tricostata* and *Halodule uninervis* (wide) were uncommon and very patchily distributed within the survey region. Small areas of *Halophila tricostata* were found in baseline surveys (November 1995 and August 1996) seaward of *Halophila ovalis. Halophila tricostata* was absent in the last three annual monitoring surveys.

An estimated 0.3 ha of low-density seagrass was initially lost as a direct result of capital dredging. There has been no seagrass regrowth in the dredged channel. Regrowth is not expected because of tidal flows and low light intensities under the turbid silt layer. Small patches of seagrass (usually *Halophila ovalis)* were found immediately adjacent to the dredged channel each year.

Halophila decipiens did not occur close (within 300m) to Oyster Point during the study. Its distribution/location and area varied widely between years, with an overall increase in area from 73.8 ±8.8ha (November 1995) to 87.7 ±9.3ha (December 1999) (Table 1, Map 4). *Halophila ovalis* and *Halodule pinifolia/uninervis* (narrow) area did not vary significantly between years (Table 1, Map 3 & Map 5).

Table 1. Frequency of occurrence (sites), mean above-ground biomass and area for each seagrass species at Oyster Point in November 1995, December 1997 November 1998, and December 1999.

Species	**November 1995**			**December 1997**			**November 1998**			**December 1999**		
	sites	**Biomass (±SE) (g DW m^{-2})**	**Area (ha)**	**sites**	**Biomass (±SE) (g DW m^{-2})**	**Area (ha)**	**# sites**	**Biomass (±SE) (g DW m^{-2})**	**Area (ha)**	**# sites**	**Biomass (±SE) (g DW m^{-2})**	**Area (ha)**
Halodule pinifolia/uninervis (narrow)	78	4.16 ± 0.43	28.3 ± 8.3	117	4.86 ± 0.37	40.7 ± 8.7	125	2.89 ± 0.14	44.7 ± 9.2	73	3.93 ± 0.28	35.9 ± 8.0
Halodule uninervis (wide)	4	0.79 ± 0.19	1.0 ± 0.6	2	11.37 ± 5.55	0.1 ± 0.3	4	0.82 ± 0.32	1.6 ± 0.9	1	13.18 ±	3.5 ± 2.5
Halophila decipiens	79	3.95 ± 0.28	73.8 ± 8.8	49	2.23 ± 0.39	91.7 ± 13.0	11	0.28 ± 0.12	12.2 ± 3.1	67	2.16 ± 0.25	87.7 ± 9.3
Halophila ovalis	267	4.73 ± 0.14	199.3 ± 14.4	298	3.91 ± 0.17	213.8 ± 14.8	287	1.87 ± 0.11	224.8 ± 15.7	327	3.91 ± 0.14	263.9 ± 13.3
Halophila spinulosa	1	0.32 ± 0.16	0.20 ± 0.02	1	0.95	0.1 ± 0.2	-	-	-			-
Halophila tricostata	11	2.76 ± 0.71	3.2 ± 1.4	-	-	-	-	-	-			-
All species pooled	349	5.46 ± 0.13	285.4 ± 16.0	377	5.05 ± 0.27	285.3 ± 16.8	364	2.50 ± 0.10	252.3 ± 16.3	383	4.50 ± 0.13	312.2 ± 13.8

The seaward edge of the seagrass meadows north and south of Oyster Point varied only slightly between years. It retracted slightly in 1998 and returned to earlier (1995) limits again in 1999 (Map 2). The changes in distribution of *Halophila decipiens* (Map 4) contributed most of this variability.

Seagrasses ranged in depth from approximately 0.4 to 4.4m below MSL in 1995, 0.5 to 4.0m below MSL in 1997, 0.5 to 3.6m below MSL in 1998 and 0.5 to 3.8m below MSL in 1999. Species depth ranges were affected by the presence of only a few plants at the deeper extent of distribution. *Halodule pinifolia/uninervis* (narrow) dominated the shallowest depth zone (0.5-1m below MSL) and the *Halophila* species dominated the zone immediately seaward (mean depths 2-3m below MSL; Figure 2, Maps 3 to 5). *Halophila decipiens* extended the deepest in all four surveys (Figure 2, Map 4).

Mean depth of occurrence for *Halophila decipiens* at Oyster Point was significantly shallower in December 1997 and November 1999 than in November 1995 (0.28 and 0.24m respectively) (ANOVA F=4.23, 134 d.f., p<0.01) (Figure 2). *Halophila ovalis* and *Halodule pinifolia/uninervis* average depths did not change significantly between sampling events (ANOVA F=1.51, 728 d.f., p=0.21; F=1.71, 232 d.f., p=0.16 respectively) (Figure 2).

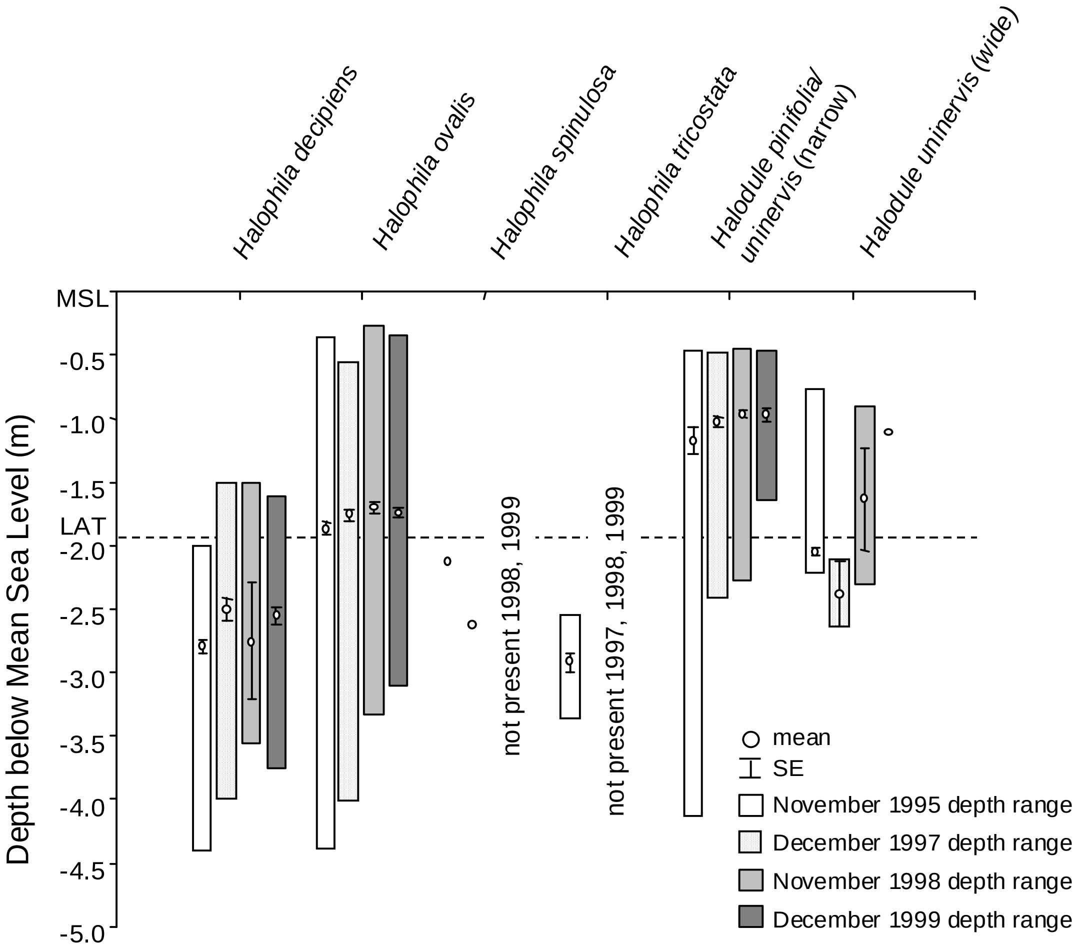

Figure 2. Mean, standard error and range of depth of occurrence for each seagrass species in the survey region at Oyster Point in November 1995, December 1997, November 1998 and December 1999; transect data only (*MSL = Mean Sea Level; LAT = Lowest Astronomical Tide*).

Seagrass Biomass

Mean aboveground biomass of seagrass at Oyster Point (all species and meadows pooled) varied little from 5.46 ±0.13 g DW m^{-2} in November 1995 to 5.05 ± 0.27 g DW m^{-2} in December 1997 but declined significantly to 2.50 ±0.10 g DW m^{-2} in November 1998 (ANOVA F=51.48, 1472 d.f., p<0.001)(Table 1). The overall 45% decline in aboveground seagrass biomass from 1995 to 1998 was followed by an 80% increase in 1999 to near the 1995 value (Figure 3, Table 1).

Changes in seagrass biomass were uneven over the survey region. At southern transects within 300m of Oyster Point, aboveground seagrass biomass did not change significantly throughout the study (Figure 4). There were gains in aboveground seagrass biomass at some transects more than 500m south of Oyster Point between 1995 and 1997 (Lee Long et al. 1999), but the overall trend for most transects was a decline (between 4 and 10g DW m^{-2}) from 1995 to 1998 followed by an increase in 1999 (Figure 4).

Declines in seagrass biomass from 1995 to 1998 occurred in the northern intertidal region (between 5 and 10 g DW m^{-2} in the 100 to 400m transects;), northern sub-tidal region (100-2000m transects; about 4 g DW m^{-2}) and in both southern regions (500m to 2000m transects) (Figure 4). Most of these declines were reversed in 1999, when decreases were minor and almost all transects increased (between 2 and 7g DW m^{-2}) in biomass. From 1995 to 1997 declines occurred in the northern intertidal region close to Oyster Point and the northern sub-tidal region >800m from Oyster Point (Lee Long et al. 1999). From 1997 to 1998 declines occurred inter-tidally and sub-tidally, but mostly 200 to 700m north of Oyster Point. An 18 g DW m-2 decline in biomass at 100m north of Oyster Point in 1997 was from one unusually high-biomass site in a small patch of seagrass recorded in 1995.

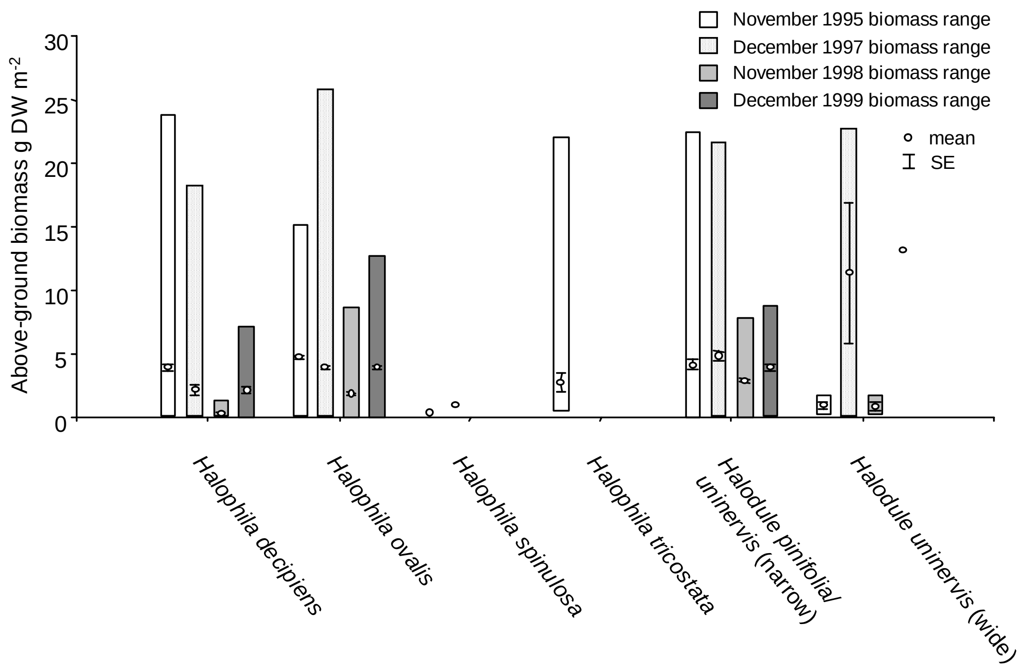

Figure 3. Mean, standard error and range of above-ground biomass for each seagrass species in the survey region at Oyster Point (sites with seagrass present) in November 1995, December 1997, November 1998 and December 1999.

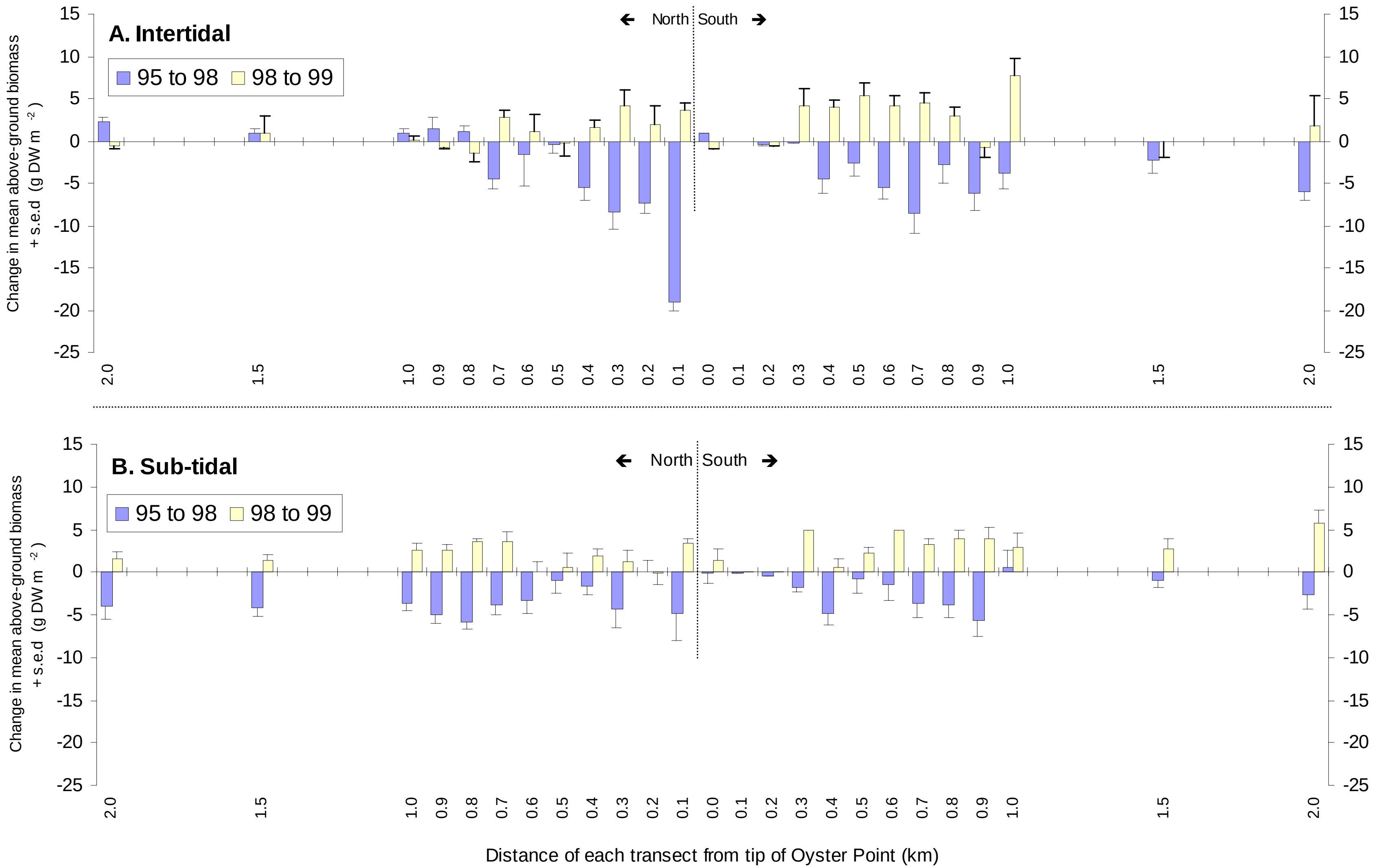

Figure 4. Changes in mean aboveground seagrass biomass (all species pooled, g DW m^{-2}) between November 1995 to November 1998 and November 1998 to December 1999 for each permanent transect at Oyster Point. A = intertidal seagrasses. B = sub-tidal seagrasses. Error bars represent the standard error of difference between the two means (s.e.d).

Sediment

A layer (2-10cm thick) of fine, silty mud was identified in 1998 at several sites north of the access channel, seaward of the 1.5m depth contour, but was not present south of the access channel (Lee Long et al. 2000). *Halophila ovalis* and *Halodule pinifolia/uninervis* plants had lost their green (chlorophyll) coloration on parts that were buried by the silt layer and a few loose plants also occurred in the silt layer. This fine silty mud was similar in texture to the fine silt layer that was present each year in the intertidal zone of the northern and southern regions. The original source of the sediment could not be determined.

In 1999 the silty mud in the northern sub-tidal region was only thin (1-3 cm) and very patchy. No silt layer was observed in the southern sub-tidal region. A powdery mud covered the consolidated mud/sand/shell substrate in some areas, but not thickly enough to smother seagrasses. Low densities of *Halophila ovalis* and *Halophila decipiens* plants were growing over the powdery mud substrate and still had green (i.e. photosynthetically active) leaves.

A thick layer of silt was also found at several sites in the dredged access channel, but not found immediately seaward of the channel. Conditions were extremely turbid and no seagrass was found in this silty flocculant layer. In December 1997 (immediately following capital dredging) it was less than 0.1m thick. It was most widespread and thickest (approx. 0.5m thick) in the channel in November 1998, but in December 1999 was only a 0.1m thick layer at several sites in the inner part of the channel - not in the seaward half of the channel. This material appears to have drifted from elsewhere and collected (or “trapped”) in the access channel and may change according to tide and flow conditions.

Climate Data

Climate data for the 2 months prior to each sampling event indicated increases from 1995 to 1998 in the number of strong wind (eastern sector, >10 knots) days (Figure 5) and cloudy (8/8 cloud-cover) days (Figure 6). The total number of cloudy days for 2 months prior to the November 1998 survey was 22 days – very high compared with the 120-year average (9.3 days) for September and October.

Winds also affected water turbidity unevenly over the survey region. Observations during this study and by SKM suggest that the northern survey region close to Oyster Point and the southern intertidal region were the most exposed to wind-driven sediment re-suspension and hence to year-to-year increases in turbidity.

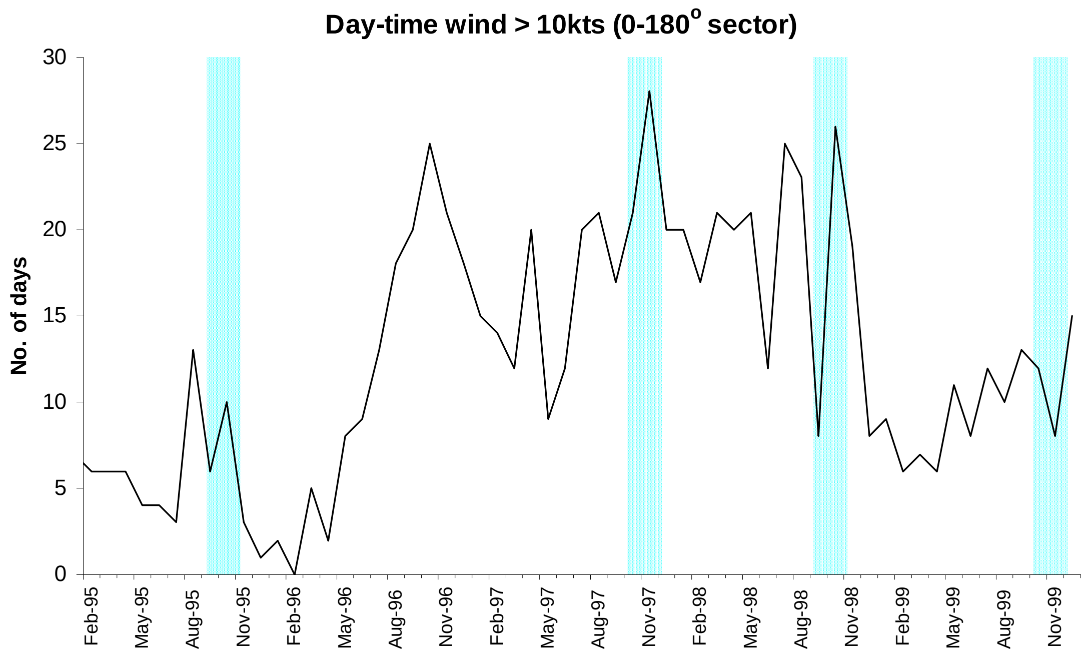

Figure 5. Number of eastern sector windy days (>10 knots at 0900 or 1500 hrs) per month at Cardwell, from February 1995 to December 1999. Data courtesy of Bureau of Meteorology, Queensland. Shaded areas indicate 2 month period prior to each sampling event.

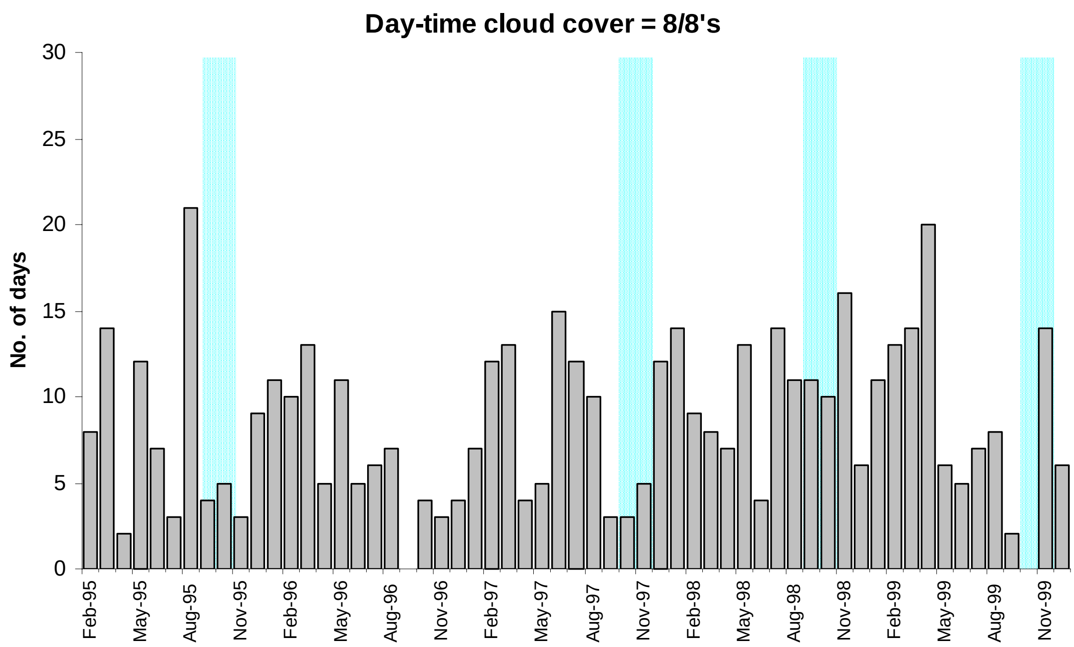

Figure 6. Number of cloudy (8/8 cloud cover at 0900 or 1500 hrs) days per month at Cardwell, from February 1995 to December 1999. Data courtesy of Bureau of Meteorology, Queensland. Shaded areas indicate 2 month period prior to each sampling event.