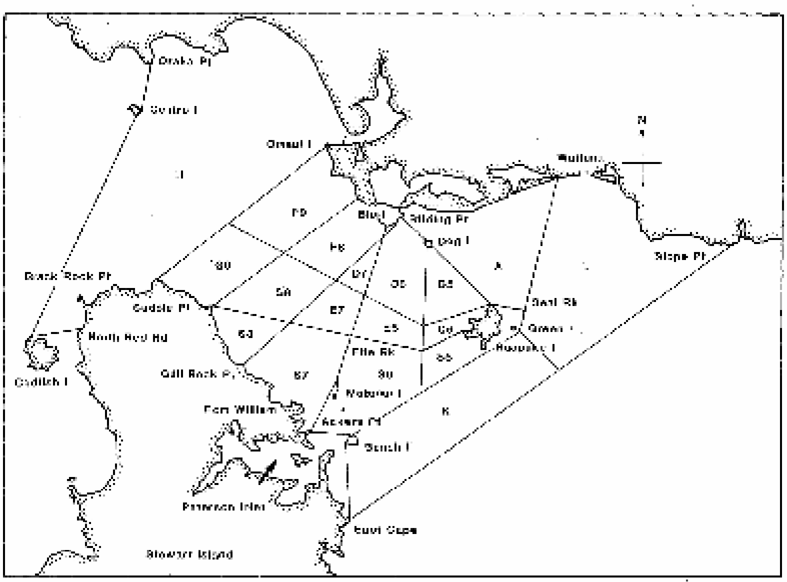
# DREDGE OYSTER (OYU 5) – Foveaux Strait

(*Ostrea chilensis*)




**The Foveaux Strait dredge oyster fishery boundaries and statistical reporting areas for catch and effort returns.**

## 1. FISHERY SUMMARY

### (a) Commercial fishery

The Foveaux Strait dredge oyster fishery has been fished for over a hundred years. From the late 1880s to 1962 the fishery was managed by limiting the number of vessels licensed to fish. During this period vessel numbers varied between 5 and 12. The fishery was de-licensed in 1962 and boat numbers increased to 30 by 1969. Boundaries of statistical areas for recording catch and effort were established in 1960 and the outer boundary of the licensed oyster fishery was promulgated in 1979. The western fishery boundary in Foveaux Strait is a line from Oraka Point to Centre Island to Black Rock Point (Codfish Island) to North Head (Stewart Island). The eastern boundary is from Slope Point, south to East Cape (Stewart Island). The OYU 5 statistical reporting areas are shown in Figure 1.

Catch limits were introduced in 1963–69 (Table 1); from 1970 vessel numbers were also regulated at 23. The catch limits were evenly divided between the 23 vessels. In 1979 the oyster fishery was declared a licensed fishery for the 23 vessels, closing a loophole that allowed vessels to fish outside the designated fishery area. Before 1992, landings and catch limits in this fishery were recorded in sacks. Sacks contained an average of 774 oysters and weighed 79 kg. Catch and effort has been traditionally recorded in sacks per hour dredged. Total landings of oysters between the 1880s and 1962 ranged between 15 and 77 million oysters. Total catches for the period 1907–1962 are shown in Table 1. Catch limits and total landings for 1963–92 are shown in Table 2.

In 1986 *Bonamia exitiosa* caused a major mortality in the population and the fishery was closed half way through the season to minimise disturbance to oysters. Management of the fishery was modified in response to the continuing mortality from *B. exitiosa*. In 1987, the infected area was closed to dredging to reduce disturbance (so as not to exacerbate infection) and the catch limit reduced in proportion to the population of the closed area (Table 1). In 1988 the restriction on fishing in infected areas was seen as inappropriate in the light of new evidence on how the disease was affected by disturbance and the catch limit was increased. In 1989 the catch limit was increased to the pre- 1986 level, with the proviso that it would be modified if catch and effort data, and the distribution of fishing showed that mortality had reduced the population further (through this period, catch and effort data provided the only information on abundance of oysters in the fishery). *B. exitiosa* infection and mortality continued to spread through Foveaux Strait and by 1990 mortality in the area first infected had reduced oyster density below a level that could be fished economically. The quota remained at 89 million oysters for the 1990 season. However, four weeks of fishing showed that mortality from *B. exitiosa* had become widespread and reduced the oyster population over much of Foveaux Strait. The quota was reduced to 36 million oysters. In 1991 an additional 14 million oysters were dredged from a strip in central Foveaux Strait to reduce the density of oysters with the aim of containing infection by *B. exitiosa* to the west. This strategy failed and infection and mortality continued to spread east. The devastated beds in central Foveaux Strait were closed in 1992 and fishing confined to the outer beds. The catch rate was the lowest in the recent history of the fishery and fishers caught less than a third of the catch available. In 1993, Foveaux Strait was closed to commercial fishing to allow the population to recover.

After three years, the population had rebuilt sufficiently for the Minister of Fisheries to reopen the fishery in 1996 with a catch limit of 14.95 million oysters (equivalent to 15 million oysters). This catch limit was converted to a catch quota of 1475 t using a conversion factor of 801 oysters per 79 kg sack. The mean number of oysters per sack landed in 1996 was fewer than 801 so that the quota specified by weight was filled before 14.95 million oysters were landed. The number of sacks landed as well as the number of oysters they contained was tabulated from the 1996 Licensed Fish Receivers Reports (LFLR) data and a new conversion factor of 774 oysters per 79 kg sack estimated. Using this conversion factor, the catch quota for 1997–2001 was 1525 t. From 1996, catches were recorded as numbers of oysters, catch limits and total landings for 1996–2006 are shown in Table 3.

Between 1992 and 2000 the Bluff Oyster Management Company Ltd was granted a special permit to catch oysters during the breeding season as part of their study of the viability of enhancing the oyster population, using spat settled on oyster shell. Permit allocations and reported landings are shown in Table 4. No special permit was issued in 1998.

In April 1997, individual quotas were granted and quota holders permitted to fish their entire quota on one vessel. At the same time, the Crown purchased 20% of the available quota from quota holders and transferred it to the Waitangi Fisheries Commission. The oyster fishery entered the Quota Management System in 1998. The number of vessels in the fishery has dropped from 23 in 1996, to 15 in 1997, and now at 11.

Monitoring the status of *B. exitiosa* infection between 1994 and 2000 indicated infection was effectively absent from the fishery; however, a survey in March 2000 confirmed another outbreak. This survey found localised areas of oysters with heavy *B. exitiosa* infection and high recent mortality; and areas with low prevalence but high intensity of infection which were likely to experience some mortality from the disease in the immediate future. This *B. exitiosa* epizootic began at a similar location to the mid 1980s epizootic, and then proceeded to spread throughout Foveaux Strait over a period of several years. It was considered possible that the recent outbreak would also spread in a similar manner. Surveys in October 2001, January and March 2002 found all areas with high densities of recruited oysters (including the designated commercial areas) had a high prevalence of infection and some high intensity patches of infected oysters within or near them. The estimated size of the commercial population in March 2002 suggested a reduction to about 40–65% of the estimated population from October 2001. Infection from *B. exitiosa* was expected to cause further mortality in the future.

Oysters have been traditionally harvested over a six-month season, 1 March to 31 August. When the fishery was reopened in 1996, the oyster season started between mid March and early

June to avoid disturbing oysters after spawning and reduce the risk of infection by *B. exitiosa*. The oyster season continued to finish on 31 August.

Oysters have been commercially harvested from Foveaux Strait since the 1860s, and since the 1870s by dredge. Currently vessels tow two 550 kg, double bit, steel dredges on steel warps. Each dredge is towed off its own derrick, both on the vessel's port side. The dredges are towed along an elliptical track. Once the dredges are shot the vessel drifts down tide under minimal power turning in to the tide to haul the dredge. The dredge contents are emptied on to culching benches and the oysters sorted and sized by hand. Small oysters and bycatch are returned to the sea. Oysters are landed daily, live in the shell.

**Table 1: Reported landings of Foveaux Strait oysters 1907–1962 (millions of oysters; sacks converted using numbers assuming a conversion rate of 774 oysters per sack for the years 1907–1992). (Data summarised by Dunn 2005 from 1907–1962 from Marine Department Annual Reports).**

| Year | Catch | Year | Catch | Year | Catch | Year | Catch | Year | Catch |
|---|---|---|---|---|---|---|---|---|---|
| 1907 | 18.83 | 1919 | 16.56 | 1931 | 28.28 | 1943 | 56.59 | 1955 | 60.84 |
| 1908 | 17.34 | 1920 | 20.67 | 1932 | 29.01 | 1944 | 49.50 | 1956 | 58.63 |
| 1909 | 19.19 | 1921 | 19.01 | 1933 | 32.64 | 1945 | 58.85 | 1957 | 60.14 |
| 1910 | 18.20 | 1922 | 21.11 | 1934 | 40.44 | 1946 | 69.16 | 1958 | 64.44 |
| 1911 | 18.90 | 1923 | 22.28 | 1935 | 38.48 | 1947 | 63.09 | 1959 | 77.00 |
| 1912 | 19.00 | 1924 | 18.42 | 1936 | 49.08 | 1948 | 73.10 | 1960 | 96.85 |
| 1913 | 26.26 | 1925 | 20.01 | 1937 | 51.38 | 1949 | 75.34 | 1961 | 84.30 |
| 1914 | 19.15 | 1926 | 21.54 | 1938 | 52.05 | 1950 | 58.09 | 1962 | 53.42 |
| 1915 | 25.42 | 1927 | 16.26 | 1939 | 58.16 | 1951 | 70.15 | | |
| 1916 | 22.61 | 1928 | 30.03 | 1940 | 51.08 | 1952 | 72.51 | | |
| 1917 | 17.20 | 1929 | 30.44 | 1941 | 57.86 | 1953 | 55.44 | | |
| 1918 | 19.36 | 1930 | 33.11 | 1942 | 56.87 | 1954 | 51.29 | | |

**Table 2: Reported landings and catch limits for the Foveaux Strait dredge oyster fishery from 1963–92 (millions of oysters; sacks converted to numbers assuming a conversion rate of 774 oysters per sack). Catch rate shown in sacks per hour.**

| Year | Reported landings | Catch limit | Catch rate | Year | | Catch limit | Catch rate |
|---|---|---|---|---|---|---|---|
| 1963 | 58 | 132 | 6.0 | 1978 | 96 [2] | 89 | 17.1 |
| 1964 | 73 | 132 | 6.8 | 1979 | 88 | 89 | 16.6 |
| 1965 | 95 | 132 | 7.9 | 1980 | 88 | 89 | 15.2 |
| 1966 | 124 | 132 | 10.6 | 1981 | 89 | 89 | 13.4 |
| 1967 | 127 | 132 | 9.3 | 1982 | 88 | 89 | 13.2 |
| 1968 | 114 | 121 | 7.7 | 1983 | 89 | 89 | 12.3 |
| 1969 | 51 | 94 | 6.5 | 1984 | 89 | 89 | 13.8 |
| 1970 | 88 | 89 | 7.3 | 1985 | 82 | 89 | 12.1 |
| 1971 | 89 | 85 | 6.9 | 1986 | 60 [3] | 89 | 10.5 |
| 1972 | 77 | 85 | 6.7 | 1987 | 48 | 50 | 10.9 |
| 1973 | 97 [1] | 85 | 10.0 | 1988 | 68 | 71 | 10.0 |
| 1974 | 92 [1] | 85 | 11.5 | 1989 | 66 | 89 | 10.7 |
| 1975 | 89 | 89 | 11.9 | 1990 | 36 | 36 | 6.4 |
| 1976 | 89 | 89 | 13.4 | 1991 | 42 [4] | 36 | 5.8 |
| 1977 | 92 [2] | 89 | 15.9 | 1992 | 5 [5] | 14 | 3.4 |

***1*** Landings include catch given as incentive to explore 'un-fished' areas.
***2*** Landings include catch given as an incentive to fish Area A.
***3*** Season closed early after diagnosis of *B. exitiosa* infection confirmed.
***4*** Landings include catch given as an incentive to fish a 'firebreak' to stop the spread of *B. exitiosa*.
***5*** Fishing only permitted in outer areas of fishery.

**Table 3: Reported landings and catch limit for the Foveaux Strait dredge oyster fishery from 1996–2005. Landings and catch limits reported in numbers (millions) of oysters. Catch rate converted to sacks per hour (774 oysters per sack) to compare with earlier**

**data. Catch rate does not include oysters taken by crew as recreational catch. Reported catch rate based on number of sacks landed in CELR data and revised catch rate based on numbers of oysters landed and converted to sacks.**

| Year | Reported landings) | Catch limit | Reported catch rate | Revised catch rate |
|---|---|---|---|---|
| 1996 | 13.41 | 14.95 | 5.9 | 5.8 |
| 1997 | 14.82 | 14.95 | 7 0 | 7.0 |
| 1998 | 14.85 | 14.95 | 8.3 | 6.7 |
| 1999 | 14.94 | 14.95 | 7.5 | 6.8 |
| 2000 | 14.43 | 14.95 | 7.2 | 6.4 |
| 2001 | 15.11 | 14.95 | 7.0 | 6.8 |
| 2002 | 14.45 | 14.95 | 3.2 | 3.3 |
| 2003 | 7.46 | 14.95[1] | 2.3 | 2.6 |
| 2004 | 7.48 | 14.95[1] | 2.2 | 2.5 |
| 2005 | 7.57 | 14.95[1] | 1.7 | 1.8 |

*1* Fifty percent of the TACC shelved for the season.

**Table 4: Reported oyster catch of vessels fishing under special permits for the Bluff Oyster Management Company 1992–2000. Fishing took place over the summer breeding season (November–February) rather than the winter season (March–August) of commercial fishing.**

| **Summer** | **Reported catch** (millions of oysters) | **Permit allocation** (millions of oysters) |
|---|---|---|
| 1992–93 | 2.43 | 3.10 |
| 1993–94 | 3.09 | 3.10 |
| 1994–95 | 3.03 | 3.10 |
| 1995–96 | 0.93 | 0.93 |
| Summer | | |
| 1996–97 | 0.20 | 0.88 |
| 1997–98 | 0.72 | 0.72 |
| 1998–99 | 0 | 0 |
| 1999–2000 | 1.00 | 1.00 |

## b) Recreational Fishery

In 2002, Fisheries Officers estimated that between 70 and 100 recreational vessels were fishing from Bluff and smaller numbers from Riverton and Colac Bay. Most of these vessels are fitted with GPS and capable of fishing Foveaux Strait with up to four recreational fishers on board. Recreational fishers may take 50 oysters per day during the open season. The charter boat fleet at Stewart Island, Bluff and Riverton target oysters during the oyster season. Around seventeen include oyster dredging and oyster diving trips as part of their winter programme. Some vessels can have up to 15–20 fishers out for the day (each returning with 50 oysters).

Three national surveys of recreational fishing have been conducted to estimate recreational harvest. The 1996 survey (Bradford 1998) estimated 106,000 dredge oysters were harvested in OY5, 1999-001 (Boyd & Reilly 2004) 38,000 and 2000-01 (Boyd, Gowing & Reilly 2004) 129,000. However, the catch of oysters cannot be reliably quantified from these surveys because of the small number of local respondents who reported catches of oysters in their diaries and the identification of oysters as either dredge oysters or generic oysters. The Marine Recreational Fisheries Technical Working Group (RTWG) reviewed the harvest estimates the national surveys and concluded that the estimates from 1996 were unreliable due to a methodological error. While the same error did not apply to the subsequent national surveys undertaken in 1999/200 and 2000/2001, the estimates for some fishstocks were considered to be unbelievably high.

The Southland Recreational Marine Fishers Association estimated the annual recreational catch of oysters in Foveaux Strait in 1995 to be about 301,860 oysters. Fisheries Officers believe the recreational catch has increased significantly since (Steve Logie, MFish, Invercargill, pers. comm.).

The commercial oyster fleet are a major contributor to the level of recreational harvest. Commercial fishers are entitled to 50 oysters each fisher each day, with each commercial vessel's crew potentially taking up to 300 oysters as recreational catch each day. Recreational catches from commercial vessels are reported in Catch and Effort Returns as OYS 5 (compared with OYU 5 for commercial landings). Annual catches are shown in Table 5.

**Table 5: Reported annual recreational catch of oysters taken from commercial vessels 2002–05 (Allen Frazer, MFish, Dunedin, pers. comm.).**

| Year | Number of oysters |
|---|---|
| 2001/2002 | 236 103 |
| 2002/2003 | 282 645 |
| 2003/ 2004 | 146 567 |
| 2004/2005 | 190 345 |

Overall, the total recreational catch is estimated to be about 0.5 million oysters. However the reliability of this estimate is not known.

## c) Maori customary fisheries

Reporting of Maori customary harvest is specified in the Fisheries (South Island Customary Fisheries) Regulations 1999. Ngai Tahu administers reporting of customary catch of Foveaux Strait oysters to the Ministry of Fisheries quarterly. Reported customary catch for 1998 to 2005 is given in Table 5. Customary catch increased from 0.18 million oysters in 1999 to 0.26 million oysters 2001. Little customary fishing is believed to takes place between 31 August and mid November while oysters are spawning.

**Table 5: Reported quarterly customary catch (numbers of oysters) 1 July 1998 to 31 December 2005 from Tangata taiki data collected by Ngai Tahu. NA denotes no data available.**

| Year | 1 Jan-31 Mar | 1 Apr-30 Jun | 1 Jul-30 Sep | 1 Oct-31 Dec | Total |
|---|---|---|---|---|---|
| 1998 | NA | NA | 106 380 | 37 560 | 143 940 |
| 1999 | 0 | 107 520 | 69 840 | 0 | 177 360 |
| 2000 | 63 582 | 113 634 | 34 356 | 11 760 | 223 332 |
| 2001 | 25 514 | 136 973 | 72 996 | 23 760 | 259 243 |
| 2002 | 0 | 117 219 | 67 116 | 0 | 184 335 |
| 2003 | 1 560 | 85 920 | 45 840 | 0 | 157 980 |
| 2004 | 26 546 | 9 820 | 91 342 | 0 | 127 708 |
| 2005 | 43 320 | 25 920 | 7 224 | 0 | 76 464 |

## d) Illegal catch

The Ministry of Fisheries estimated the illegal catch of oysters for the 1998 and 1999 fishing years to be about 10% of the total non-commercial catch, 66436 oysters. However, because the estimate of illegal catch cannot be verified, the Working Group is not in a position to modify or determine its acceptability.

**e) <u>Other Sources of Mortality</u>**

**i) Mortality caused by *Bonamia exitiosa***

In New Zealand flat oysters, a protozoan (Alveolata, haplosporidia) *Bonamia exitiosa* is an obligate parasite of haemocytes. Mortality of oysters from *B. exitiosa* appears to be a recurrent feature of the Foveaux Strait oyster population dynamics. Large numbers of new clocks (shells of oysters that had died within six months) and oysters in poor condition, both indicative of *B. exitiosa* epizootics, were recorded as far back as 1906. A *B. exitiosa* epizootic was confirmed in the Foveaux Strait oyster fishery in 1986–92 and again in 2000–06. Prevalence of infection between epizootics is low (almost undetectable), nevertheless, infection appears to be widespread at these low levels throughout the oyster population.

In late winter each year the parasite occurs at very low levels in apparently healthy oysters. It starts to increase in numbers in November-December, when many oysters are going through the male reproductive cycle. By February, most oysters are in the female cycle and many infected oysters fail to spawn; further proliferation of the parasite after this time results in elevated oyster mortality from March to May. From May to August *B. exitiosa* enters a late developmental phase, with increasing senescence among the parasite population, leading to an apparent population collapse. The relationship between the intensity and prevalence of infection in one year, the density of oysters, and the probability of an outbreak the following year are poorly understood (see(Sullivan et al. 2005).

Mortality from *B. exitiosa* 1986–92 reduced the Foveaux Strait oyster population to below 10% of its pre disease level in six years. A survey in March 2000 of oyster beds in the vicinity of a reported *B. exitiosa* outbreak confirmed the presence of *B. exitiosa* infection and described the extent of the outbreak (Dunn et al. 2000). The survey found heavy infection of *B. exitiosa* and recent mortality in a localized area. The *B. exitiosa* epizootic in the late 1980s began in the same general area, and proceeded to spread throughout Foveaux Strait over a period of several years. It was considered possible that the recent outbreak would also spread in a similar manner. Estimated mortality of recruited oysters (as determined by the proportion of recruit sized new clocks) in 2001 within the focus of infection was about 12% (95% confidence interval 11–13%), with peak mortality of 56% (95% confidence interval 48–64%). A further 10% (95% confidence interval 5–15%) of recruited oysters outside the main focus showed signs of infection. Beyond the focus of infection, recent mortality was 2%, and 2% showed signs of infection. Between 2000 and 2002, infection from *B. exitiosa* caused mortality in 66% of recruited oyster in Foveaux Strait and 72% by 2005. Mortality of oysters in designated commercial fishery areas was 50% by 2002, and oyster density reduced to one third.

It is not known whether other disease agents (including an apicomplexan, *Bucephalus* sp., coccidian, and microsporidian) contributed to or caused mortality in oysters during the 1986–92 and 2002–05 epizootics.

**ii) Incidental mortality caused by heavy dredges**

Since 1968, heavy double bit double ring bag dredges have been used in the fishery. The dredges weighed 410 kg when first introduced, but were rebuilt more heavily in 1984 and now weigh around 550 kg. These dredges are three and a half times heavier than the single bit single ring bag dredges employed between 1913 and 1968.

Incidental mortality of oysters from dredging with light (320 kg) and heavy (550 kg) dredges was compared experimentally in March 1997 (Cranfield et al. 1997). Oysters in the experiment had only a single encounter with the dredge. Numbers of dead oysters were counted at the end of the experiment seven days after dredging. The experiment found that mortality was inversely proportional to the size of oysters damaged and that lighter dredges damaged and killed fewer oysters. Recruit size oysters appeared to be quite robust (1–2% mortality) and few were damaged, pre-recruit (10–57 mm in length) less so (6–8%), but spat were very fragile and many were killed especially by the heavy commercial dredge (mortality of spat below 10 mm in height ranged from 19–36%). Incidental mortality from dredging may reduce subsequent recruitment in heavily fished areas but is unlikely to be important once oysters are recruited. The mortality demonstrated experimentally here has not been scaled to the size of the fishery and therefore its importance cannot be assessed.

## 2. BIOLOGY

The biology of *Ostrea chilensis* has been summarised by (Sullivan et al. 2005). Since 2004, stock assessment for OYU 5 has been based on projections from the Foveaux Strait Oyster stock assessment model. The biological inputs, priors, and assumptions are summarised from (Dunn 2005).

### a) Recruitment

Little data are available on recruitment. Relative year class strengths area were assumed to average 1.0 over all years of the model, and further, relative year class strengths in the period before 1985 were assumed constant, and defined to be equal to the initial recruitment. Lognormal priors on relative year class strengths were assumed, with mean 1.0 and c.v. 0.2.

Stock recruitment relationships for the Foveaux Strait dredge oyster are unknown, but most surviving oysters post settlement, are typically found on live oysters (Keith Michael, NIWA, pers. comm.). Typically, recruitment for sessile organisms is highly variable and often environmentally and predation driven (see Jamieson & Campbell 1998 and (Cranfield 1979). A strong recruitment pulse was observed in the fishery between 1993 and 2000, suggesting that high levels of recruitment are plausible during periods of low abundance. More recently, even at low stock levels, the numbers of small oysters found in population surveys have remained relatively high.

### b) Growth

Dunn et al. (1998b) estimated seasonal growth that allowed for areal, yearly, and breakage effects. The complexity of these estimates cannot easily be reproduced within the population model and hence the data were re-fitted using maximum likelihood von Bertalanffy growth model based on the parameterisation of Francis (see (Dunn 2005).

Winter length measurements were ignored, and hence annual growth increment measurements only were considered. The growth parameters at $a = 30$ and $b = 55$ were estimated outside the population model, as $g_a = 11.91$ mm and $g_b = 3.61$ mm; variation in growth had an estimated c.v. of c=0.31 and $\sigma_{min}$=4.45 mm; and estimated measurement error $\sigma_E$ was 2.12 mm.

## c) Maturity

(Jeffs & Hickman 2000)estimated measures of maturity from the re-analysis of sectioned oyster gonads. The data for the proportion of oysters with female ova, during the months of October–March, were used to determine the maturity ogive within the model. Figure 2 shows the estimated proportions mature (i.e., proportions of oysters with presence of female ova) by length class, along with exact 95% confidence intervals. Maturity was not considered to be a part of the model partition.

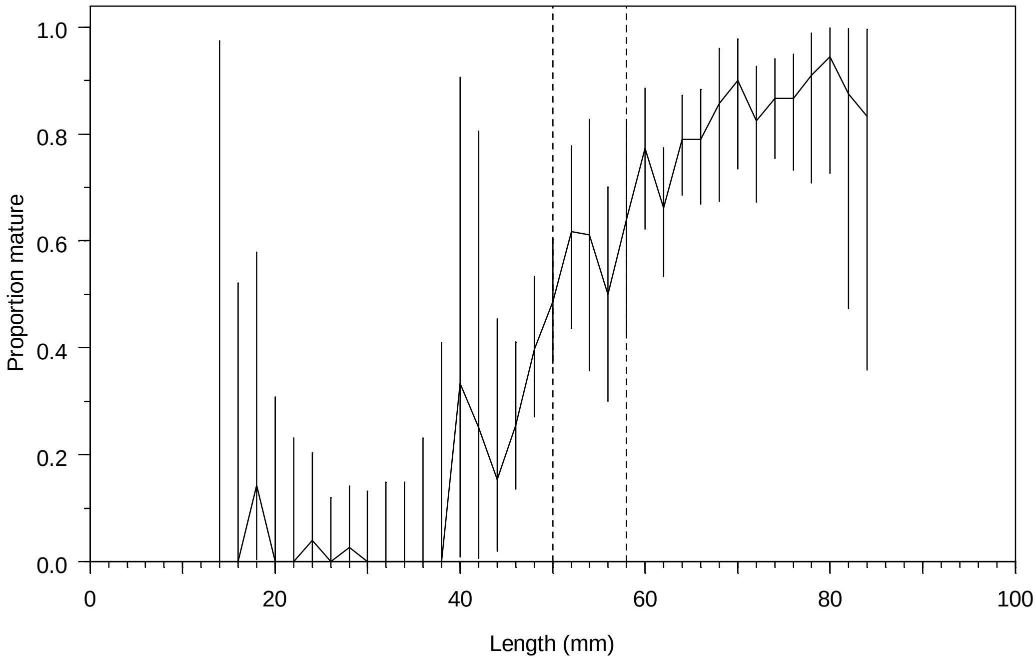



**Figure 2: Proportions of mature oysters (defined as the proportion of oysters with female ova) by length (Jeffs & Hickman 2000). Vertical bars give exact 95% confidence intervals, and dashed lines separate the small (<50 mm), pre-recruit (≥ 50 mm and <58 mm), and recruit (≥ 58 mm) size groups.**

## d) Natural Mortality

A constant value for natural mortality of 0.1 $y^{-1}$ was assumed, implying a maximum age (at which 1% survive) of 46 years. This assumption was based on estimates of *M* from Dunn (1998) and two oysters tagged at recruit size (one from 1973 and one from 1976 or 1977) and recaptured (live) in early 2003 (K.P. Michael, NIWA, pers. comm.). These data suggest the value of *M* plus *F* was not high, as at least two oysters lived to recruit size and survived a further 26–29 years.

## e) Disease Mortality

Data on disease mortality events are limited. Anecdotal reports exist of a mortality events indicated by large numbers of “clocks” (the articulated shells of recently-dead oysters with the ligament attaching the two valves intact) from the late 1940’s to 1960–63. The reported proportions of clock to live oysters are similar to those found in abundance surveys during the *B. exitiosa* epidemics in the early 1990s and early 2000s (Hine 1996) later noted that the most likely cause of the mortality during the 1960s was *B. exitiosa*.

The *B. exitiosa* outbreak in the late 1980s was thought to have started in 1985–86, with evidence of continued *B. exitiosa* mortality up until March 1995. No further evidence of unusual mortality was found in the fishery until the summer of 2000. Disease mortality is set to zero for the years 1907–1948 (the period before any abundance estimates); 1952–1959 (to allow for disease mortality in the late 1940s); 1967–1984 (to allow for disease mortality in the early 1960s); and 1996–1999 (to allow for the epizootic in the late 1980s and the subsequent epizootic in 2000). Where disease mortality was estimated, a normal prior with mean -0.2 (sic), standard deviation 0.2, and bounds [0.0, 0.8] were used.

Dunn (2005) assumed that the relationship between disease mortality, oyster length, or oyster maturity was the same as the maturity ogive. B. Diggles (unpublished results) analysed 500 oysters from a survey on January 2004 for *B. exitiosa* infection, sex, and maturity with lengths between 24 and 81 mm. These data provide information on the disease selectivity of oysters, and can be used to determine a length-based selectivity of *B. exitiosa* (Figure 3).

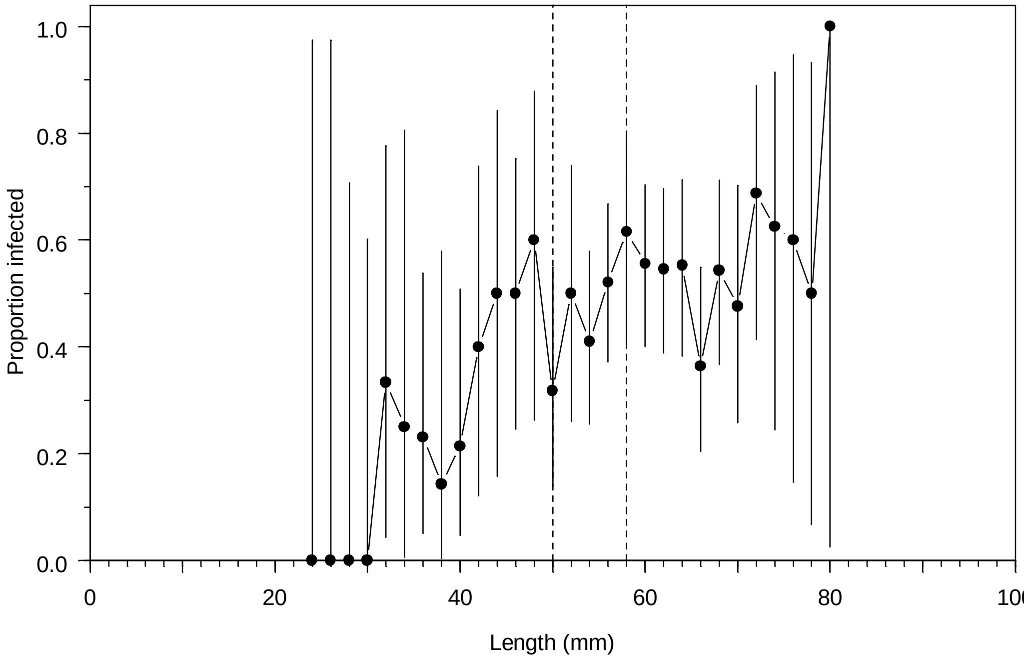



**Figure 3: Proportions of oysters (and 95% confidence intervals) with a *B. exitiosa* infection of level 1+ from *B. exitiosa* histological sampling from the January 2004 surveys by length (B. Diggles, unpublished results). Dashed lines separate the small (<50 mm), pre-recruit (≥ 50 mm and <58 mm), and recruit (≥ 58 mm) size groups.**

## 3. STOCKS AND AREAS

The population of oysters in Foveaux Strait in 1975 consisted of a number of discrete small dense patches generally separated by extensive areas of barren ground. Oyster-bearing ground covered some 1200 $km^2$ of Foveaux Strait. In 1975, ninety one percent of the total oyster population was located in about 50 small dense patches of oysters that together covered only 12 $km^2$ of the seafloor. Throughout the years, high catches of oysters have been confined to the same locations suggesting that these localised patches of oysters have remained stable in position over the history of the fishery. Between 1986 and 1992, mortality from *B. exitiosa* progressively destroyed most of the dense patches of oysters. This catastrophic mortality in the established fishery area (the 1975–76 survey area) forced fishers to expand the area fished ahead of the wave of mortality (Doonan et al. 1994).

Grid surveys between 1990 and 1993 sampled on a wider scale (1–2 nautical mile spacing between stations) than a survey in 1975 (0.3 nautical mile spacing) and were not able to delineate small dense patches (Cranfield et al. 1999). Stratified random surveys in 1995, 1997, and 1999 were aimed at estimating population size in the entire fishery area. Although data from these surveys can by used to look at macro scale distribution of oysters (areas where mean density was above a density of 400 oysters per survey tow, equivalent to 6–8 sacks per hour in commercial fishing), the distribution of sampling could not delineate small patches. Recent surveys in 1999, 2001, 2002, and 2005 have focused sampling effort on commercial areas designated by fisher's and their logbook data, to primarily estimate the size of the commercial population. These logbook data are aimed at recording commercial patches of recruited oysters down to 0.3 nautical mile and to identify areas of low oyster density from prospecting tows.

Mortality from *B. exitiosa* infection has reduced recruited oyster density to low levels throughout the commercial oyster fishery area. There is insufficient information from either surveys or logbooks to describe the distribution of oysters.

## 4. STOCK ASSESSMENT

### a) Population estimates

Surveys of the Foveaux Strait oyster population have been reported since 1906, see Table 7 and (Sullivan et al. 2005) for details. Early surveys 1906, 1926–1945 are summarised by (Sorensen 1968). Two large surveys to map oyster density were carried out in 1960–62 by (Stead 1971), and again in 1974 and 1975 by (Cranfield & Allen 1979). The efficiency of the small dredge used in 1975 and 1976 was poorly estimated at that time and the population estimate from that survey was too inaccurate for use in management. The efficiency of that survey dredge was better estimated during the surveys of 1990 and this new estimate of efficiency for the dredge was used to re-estimate the oyster population in 1975–76 to give a more accurate estimate that is comparable with recent surveys (Doonan et al. 1994).

The absolute population size was estimated in 1990 using a stratified random dive survey. The efficiency of the small survey dredge and of commercial dredges was estimated by comparing oyster density in the same areas using these dredges with the density from the dive survey. In 1992 and 1993 the population was estimated from grid pattern dredge surveys. The population was estimated from stratified random surveys in March and October 1995, and in October 1997, 1999, 2001, and 2002, and in January 2005. Surveys of the Foveaux Strait oyster population have been traditionally in October after the commercial oyster season had finished, when the seasonal mortality from *B. exitiosa* was at its lowest, and to allow sufficient time for the stock assessment process to be completed before the next oyster season began the following March. Population estimates from surveys in 1990–1997 used an estimate of dredge efficiency (0.164) and surveyed the whole fishery area with a two-phase random stratified design. Population estimates for these surveys are shown in Table 7. The 1999–2005 population surveys used a revised estimate of 0.166.

In 2000, MFish and the Bluff Oyster Management Company accepted a five-year strategic research plan (Andrew et al. 2000) to develop a length-based stock assessment model for the Foveaux Strait oyster fishery, including modelling of changes in population size, the effects of mortality from *B. exitiosa* infection, growth, mortality, fishing mortality, and the effects of fishing-induced habitat change on the oyster population. An initial Bayesian length-based single sex population model that incorporated disease mortality from *B. exitiosa* for Foveaux Strait oysters up to the end of the 2002–03 fishing year was developed. The model was further developed in 2003 and was used for the stock assessment of oysters for the 2004 oyster season and updated for the 2005 Foveaux strait oyster stock assessment (Dunn 2005).

**Table 7: Summary of Foveaux Strait dredge oyster survey data 1906–2005 and recruited oyster population size estimates (millions of oysters) along with numbers of new and old clocks in millions) from Dunn (2005). '–' indicates unknown.**

| Date | Design[1] | Area ($km^2$) | Stations | Type[2] | Category | Live | c.v. | New clocks | Old clocks | *B. exitiosa.* | Lengths | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 1906 | Unknown | *ca.* 1 200 | – | A | | – | – | – | – | – | – | (Hunter 1906) |
| Mar–Aug 1926[3] | CD | *ca.* 400 | – | B | | – | – | – | – | – | 19 272 | (Sorensen 1968) |
| Jan 1927[3] | Unknown | – | – | B | | – | – | – | – | – | 4 135 | (Sorensen 1968) |
| 1945[4] | CD | *ca.* 400 | | B | | – | – | – | – | – | – | (Sorensen 1968) |
| 1960–64 | Grid | *ca.* 1 800 | 542 | E | *Recruit* | ~1 000 | – | – | – | – | 11 576[5] | (Stead 1971b) |
| | | 1 055 | 310 | E* | *Recruit* | 3 059 | 0.21 | – | – | – | – | Re-analysed estimate |
| 1962 | Specific | – | 36 | Dive | *Recruit* | – | – | – | – | – | – | (Stead 1971b) |
| 1965–1971 | Specific | 374 | 6 | C | – | – | – | – | – | – | – | (Street & Crowther 1973) |
| 1973 | Grid | – | 150 | F | *Recruit* | – | – | – | – | – | – | (Allen & Cranfield 1979) |
| Apr–Aug 1974 | MR | 374 | – | C | *Recruit* | ~1 800 | 0.20 | – | – | – | – | (Cranfield & Allen 1979) |
| Apr–Aug 1975 | MR | 374 | – | C | *Recruit* | ~1 500 | 0.11 | – | – | – | – | (Cranfield & Allen 1979) |
| 1975–76 | Grid | 374 | 929 | F | *Recruit* | 1 140 | 0.15 | – | – | – | – | (Allen & Cranfield 1979) |
| Sep 1986 | Specific | – | 27 | F | *Recruit* | – | – | – | – | – | – | (Dinamani et al. 1987) |
| Jan 1987 | Specific | – | 67 | F | *Recruit* | – | – | – | – | – | – | (Dinamani et al. 1987) |
| Jul 1990 | Grid | 1 116 | 293 | D* | *Recruit* | 771 | 0.14* | – | – | Yes | – | (Cranfield et al. 1991) |
| | | 1 055 | 293 | D* | *Recruit* | 707 | 0.11 | 41 | 574 | – | – | Re-analysed estimate |
| Oct 1990 | SR | 646 | 83 | Dive | *Recruit* | – | – | – | – | – | 412[5] | (Cranfield et al. 1991) |
| | | 646 | 83 | Dive | *Pre-recruit* | – | – | – | – | – | 420[5] | (Cranfield et al. 1991) |
| | | 646 | 83 | Dive | *Small* | – | – | – | – | – | 1 280[5] | (Cranfield et al. 1991) |
| Oct 1990 | SR | 646 | 116 | F | *Recruit* | 607 | 0.11 | – | – | Yes | – | (Cranfield et al. 1991) |
| | | 1 055 | 116 | F* | *Recruit* | 623 | 0.12 | 35 | – | – | – | Re-analysed estimate |
| Mar 1992 | Grid | 1 229 | 370 | D* | *Recruit* | 319 | 0.18 | – | – | Yes | – | (Doonan & Cranfield 1992) |
| | | 1 055 | 293 | D* | *Recruit* | 285 | 0.12 | 2 | 285 | – | – | Re-analysed estimate |
| Oct 1993 | Grid | 875 | 177 | D* | *Recruit* | 372 | 0.21 | – | – | – | – | (Cranfield et al. 1993) |
| | | 1 055 | 177 | D* | *Recruit* | 397 | 0.10 | 1 | 292 | – | – | Re-analysed estimate |
| | | 1 055 | 177 | D* | *Pre-recruit* | 383 | 0.11 | 2 | 173 | – | – | Re-analysed estimate |
| | | 1 055 | 177 | D* | *Small* | 1 004 | 0.10 | – | – | – | – | Re-analysed estimate |
| Mar 1995 | SR | 680 | 50 | D* | *Recruit* | 543 | 0.30 | – | – | Yes | – | (Cranfield et al. 1995) |
| | | 680 | 50 | D* | *Pre-recruit* | – | – | – | – | Yes | – | (Cranfield et al. 1995) |
| | | 1 055 | 49 | D* | *Recruit* | 576 | 0.25 | 6 | 48 | – | – | Re-analysed estimate |
| | | 1 055 | 49 | D* | *Pre-recruit* | 401 | 0.28 | 15 | 40 | – | – | Re-analysed estimate |
| | | 1 055 | 49 | D* | *Small* | 402 | 0.25 | – | – | – | – | Re-analysed estimate |
| Oct 1995 | SR | 680 | 154 | D* | *Recruit* | 639 | 0.19 | – | – | – | – | (Cranfield et al. 1996) |
| | | 1 055 | 154 | D* | *Recruit* | 782 | 0.11 | 1 | 44 | – | – | Re-analysed estimate |
| | | 1 055 | 154 | D* | *Pre-recruit* | 380 | 0.10 | ~0 | 22 | – | – | Re-analysed estimate |
| | | 1 055 | 154 | D* | *Small* | 718 | 0.21 | – | – | – | – | Re-analysed estimate |
| Oct 1997 | SR | 693 | 107 | D* | *Recruit* | 630 | 0.21 | – | – | – | – | (Cranfield et al. 1998) |
| | | 1 055 | 107 | D* | *Recruit* | 660 | 0.14 | ~0 | 74 | – | – | Re-analysed estimate |
| | | 1 055 | 107 | D* | *Pre-recruit* | 727 | 0.14 | ~0 | 111 | – | – | Re-analysed estimate |
| | | 1 055 | 107 | D* | *Small* | 918 | 0.14 | – | – | – | – | Re-analysed estimate |

**Table 7 (continued): Summary of Foveaux Strait dredge oyster survey data 1906–2005 and recruited oyster population size estimates (millions of oysters).**

| Date | Design[1] | Area (km²) | Stations | Type[2] | Category | Live | c.v. | New clocks | Old clocks | *B. exitiosa.* | Lengths | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 1998 | Specific | – | – | D* | *Recruit* | – | – | – | – | Yes | – | (Cranfield 1998) |
| | | – | – | D* | *Pre-recruit* | – | – | – | – | – | – | (Cranfield 1998) |
| Oct 1999 | SR | 1 055 | 199 | D* | *Recruit* | 1 461 | 0.16 | – | – | – | – | (Michael et al. 2001) |
| | | 1 055 | 199 | D* | *Recruit* | 1 453 | 0.16 | ~0 | 176 | – | 16 054 | Re-analysed estimate |
| | | 1 055 | 199 | D* | *Pre-recruit* | 896 | 0.12 | 0 | 97 | – | 8 424 | Re-analysed estimate |
| | | 1 055 | 199 | D* | *Small* | 1 364 | 0.11 | – | – | – | 16 085 | Re-analysed estimate |
| Mar 2000 | Specific | – | 35 | D* | *Recruit* | – | – | – | – | Yes | – | (Dunn et al. 2000) |
| Oct 2001 | SR | 1 055 | 192 | G* | *Recruit* | 995 | 0.11 | 10 | 466 | Yes | 4 227 | (Michael et al. 2004b) |
| | | 1 055 | 192 | G* | *Pre-recruit* | 872 | 0.12 | 3 | 111 | Yes | 3 460 | (Michael et al. 2004b) |
| | | 1 055 | 192 | G* | *Small* | 1 410 | 0.12 | – | – | Yes | 7 475 | (Michael et al. 2004b) |
| Jan 2002 | Specific | – | 35 | G* | *Recruit* | – | – | – | – | Yes | – | (Dunn et al. 2002b) |
| Mar 2002 | Specific | – | 35 | G* | *Recruit* | – | – | – | – | Yes | – | (Dunn et al. 2002a) |
| Oct 2002 | SR | 1 055 | 155 | G* | *Recruit* | 502 | 0.14 | 68 | 587 | Yes | – | (Michael et al. 2004a) |
| | | 1 055 | 155 | G* | *Pre-recruit* | 520 | 0.11 | 11 | 94 | Yes | – | (Michael et al. 2004a) |
| | | 1 055 | 155 | G* | *Small* | 1 243 | 0.10 | – | – | – | – | (Michael et al. 2004a) |
| Feb 2003 | Specific | – | 16 | G* | *Recruit* | – | – | – | – | Yes | – | (Dunn et al. 2003) |
| Jan 2004 | Specific | – | 40 | G* | *Recruit* | – | – | – | – | Yes | – | (K.P. Michael, unpublished) |
| Jan 2005 | SR | 1 055 | 80 | G* | *Recruit* | 408 | 0.13 | 3 | 287 | Yes | – | (K.P. Michael, unpublished) |
| | | 1 055 | 80 | G* | *Pre-recruit* | 415 | 0.15 | 4 | 152 | Yes | – | (K.P. Michael, unpublished) |
| | | 1 055 | 80 | G* | *Small* | 1 345 | 0.12 | – | – | Yes | – | (K.P. Michael, unpublished) |

1. Survey designs either circumscribed the known oyster beds (CD), sampled specific stations non-randomly (specific), followed a grid pattern (grid), were stratified random (SR), or were mark-recapture surveys (MR).
2. * indicates a calibrated estimate. A–F indicate the type of dredge, while 'Dive' indicates a dive survey. The dredges are: (A) Light, hand-hauled commercial dredge about 1 m-wide, used up to 1913; (B) Commercial dredge, about 3.35 m-wide with single-bit and single ring bag, weighing ~150 kg and used up to 1968; (C) Commercial dredge, about 3.35 m-wide, introduced in 1968 with double-bit and double ring bag and weighing about 400 kg; (D) The 1968 commercial dredge, about 3.35 m-wide, modified in 1984 increasing weight to about 530 kg; (E) 0.91 m-wide light survey dredge with a rigid mesh catch bag; (F) 1.25 m-wide survey dredge, designed to be a smaller version of 1968 commercial dredge with double-bit and double flexible ring bag; (G) 3.32 m-wide commercial dredge similar to the 3.35 m-wide dredge introduced in 1968 with double-bit and double ring bag, and weighing 400 kg.
3. The original reports detailing the Mar–Aug 1926 and Jan 1927 surveys have been lost; these summaries are reproduced from Sorensen (1968).
4. Data from the 1945 survey were never analysed and are suspected of being destroyed in a fire in the 1950s.
5. Data recorded as height, not length. In the October 1990 dive survey, height frequencies were grouped by size class according to the height measurement, and not their ability to pass through a 50 mm or 58 mm diameter ring.

**b) <u>Estimate of the commercial population and yield</u>**

Before the *B. exitiosa* epizootic in 1986, fishers had a choice of up to 50 persistent localised areas (oyster beds) to fish (Cranfield et al. 1999). They were able to employ a pattern of fishing that rested areas that did not produce commercially acceptable catch rates. As the number of areas declined by to mortality from *B. exitiosa*, and the catch rates accepted as commercially viable dropped across the fishery, fishing became more focused on the remaining oyster beds.

Before the fishery was reopened in 1996, the Ministry of Fisheries, the Bluff Oyster Management Company and NIWA agreed to change the method of calculating the population size for estimating yield, to prevent recruitment over fishing in the few areas where the oyster population was rebuilding. Since 1996 yield estimates have been based on estimates of commercial population size, i.e. the proportion of the population that will be fished. Estimates of commercial population size in 1996–99 used the portion of the population over 400 oysters per tow (equivalent to a commercial catch rate of 6–8 sacks per hour) from the entire Foveaux Strait fishery area. Estimates of commercial population size from the 2000 fishing year have been based on an estimate of the entire recruited oyster population size in areas designated as ‘commercial’ by fishers.

The population of recruited oysters in the designated commercial fishery areas 1999–2005 is given in Table 9, and commercial areas since 2002 in Figure 4. The mean commercial population size in 2002, 143.7 million (93.3–216.4 million) is similar to 164.8 million (103.4–252.3 million) in 2005. The area of the designated commercial areas increased from 173.3 km$^2$ in 2002 to 366.9 km$^2$ in 2005, and the oyster density in these areas has halved from 0.8 oysters/m$^2$ to 0.4/m$^2$ over the same period, mainly from continuing mortality from *B. exitiosa*.

**Table 11: The population estimates for recruited oysters in designated commercial areas 1999–2005; surveys was completed in October 1999–2002 and January 2005; the number of stations sampled (No. stations), the mean oyster density per m$^2$ (mean density), standard deviation (*s.d.*) of the density estimate, coefficient of variation (*c.v.*) of the population estimate, mean population size (Mean population with upper and lower 95 % confidence intervals in parenthesis), and the area of each survey.**

| Year | No. stations | Mean density | s.d. | c.v. | Mean population | | Area km2 |
|---|---|---|---|---|---|---|---|
| 1999 | 135 | 2.41 | 0.36 | 0.16 | 275 | (184–408) | 103 |
| 2001 | 103 | 2.48 | 0.18 | 0.07 | 295 | (196–441) | 119 |
| 2002 | 92 | 0.83 | 0.08 | 0.09 | 144 | (93–216) | 173 |
| 2005 | 80 | 0.44 | 0.05 | 0.12 | 164 | (103–252) | 366 |
| 2006* | 35 | 0.43 | 0.05 | 0.13 | 124 | (77–190) | 285 |

* Not all commercial strata were resampled in February 2006.

Before the 2004 OYU 5 stock assessment, the Foveaux Strait oyster fishery was managed by current annual yield (CAY, Method 1 (Sullivan et al. 2005) based on survey estimates of the population in designated commercial fishery areas. Since 2004, the TACC has been based on estimates of recruit size stock abundance from the Foveaux Strait oyster stock assessment model (Dunn 2005).

Estimates of CAY used an exploitation rate 0.08, equal to the equilibrium fishing mortality rate for the period 1976 to 1986. The oyster population had sustained a mean harvest level of about 89 million oysters between 1976 and 1986 and this appeared to be sustainable. The oyster population was estimated in 1976 and the associated fishing mortality was assumed to equate to a sustainable exploitation rate. However, this assumption does not allow for episodic mortality from *B. exitiosa* which seems to be a recurring feature of the fishery. Nor does it take into account possible long-term changes to the fishery caused by dredging.

The exploitation rate was estimated at 0.078 (rounded to 0.08), assuming a mean of 774 oysters per sack and the population was in equilibrium at the fishing mortality rate before the *B. exitiosa* epizootic.

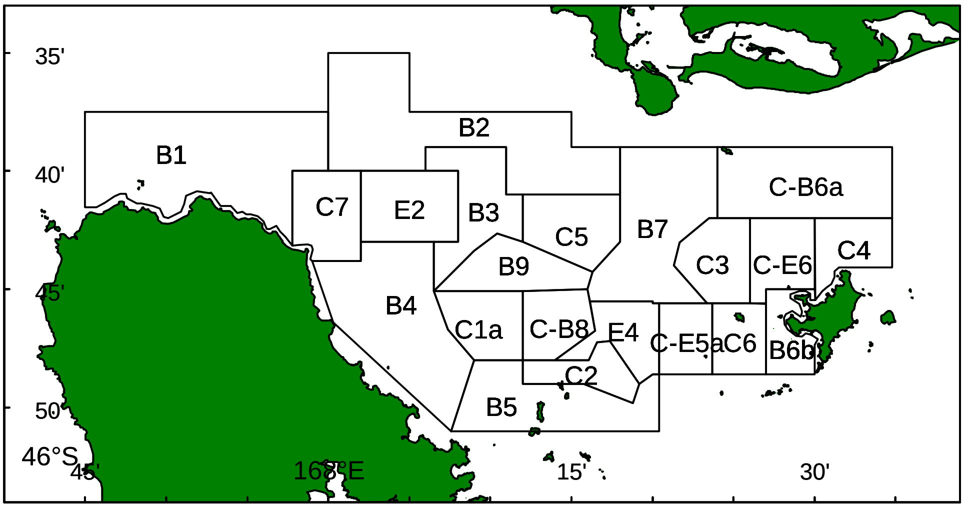



**Figure 4: The survey area and stratifications used for the 2002 survey design. Strata designated commercial are those strata defined by the hashed region and "C" prefix. Exploratory strata are those designated by an "E" prefix, and background strata by "B" prefix. Yield was calculated from the estimate of total recruited oyster population size from commercial strata only.**

A major source of error in the estimate of yield is the estimate of dredge efficiency and its' impact on the estimate of commercial population size. Dredge efficiency was last calculated in 1990. The distribution of oysters, the structure of commercial fishery areas, the substrate and epifauna, and the number of clocks (shells of dead oysters) are likely to have changed since then and may effect dredge efficiency.

### c) Estimates of recruit size stock abundance

In 2004, Dunn (2005) presented a Bayesian, length-based, single-sex, stock assessment model for Foveaux Strait dredge oysters. The base case from that assessment has been updated to include data from the 2003–04 fishing year and the abundance indices from the February 2005 survey. The stock assessment was implemented using Bayesian estimation with the general-purpose stock assessment program CASAL.

There has been a dramatic reduction in the vulnerable abundance of oysters since the outbreak of the recent *B. exitiosa* epizootic, but exploitation rates had remained low. The current spawning stock size from that assessment was about 20% (19–22%) $B_0$, and recruit-sized stock abundance ($_rB_{2003}$) was about 9% (8–11%) of initial state ($_rB_{1907}$). Dunn (2005) also stated that there was considerable uncertainty about the possible level of future recruitment and *B. exitiosa* related mortality, with the future stock status depending primarily on the level of future disease mortality.

The updated model estimates presented in Figure 3 suggest a similar state, with the exception that the levels of *B. exitiosa* mortality appear to be reducing. Model estimates of spawning stock population in 2005 was about 16% (13–18%) $B_0$, and recruit-sized stock abundance ($_rB_{2005}$) was about 9% (7–11%) of initial state ($_rB_{1907}$). While uncertainty exists in levels of future recruitment and continued *B. exitiosa* related mortality, projections indicate that current catch levels are unlikely to have any significant impact on future stock levels. Instead, future disease mortality will determine future stock status. Depending on the level of assumed disease mortality, projected status in 2008 ranged from about 80% more than the current level (with nil disease mortality) to about 80% of the current level (assuming disease mortality of 0.4 $y^{-1}$). See Dunn (2005) for details.

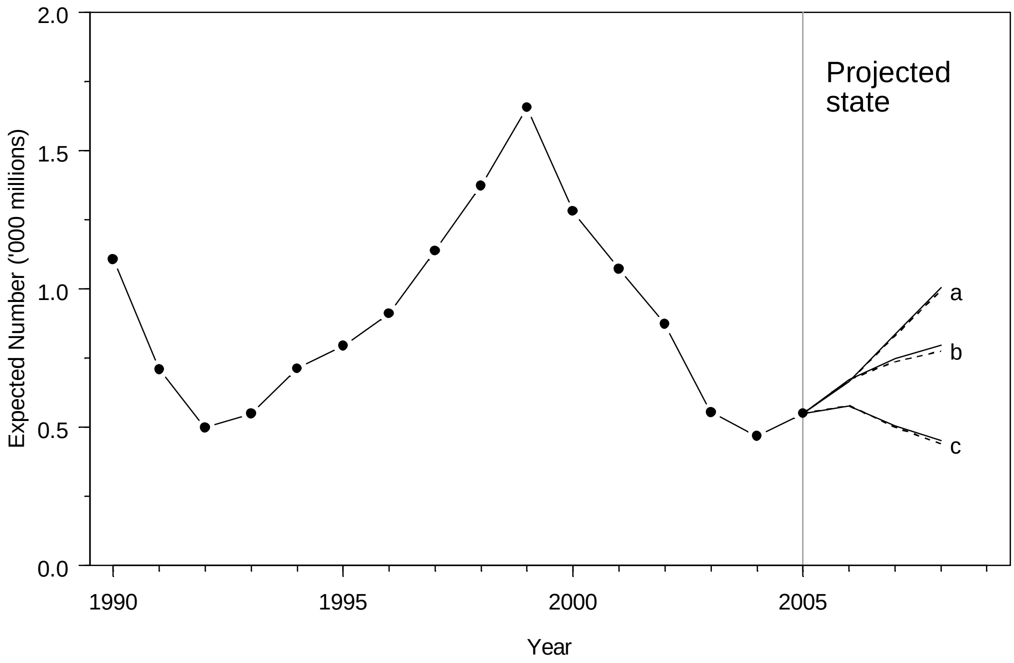



**Figure 3: Model estimates of recent recruit-sized stock abundance and projected recruit-sized stock abundance for 2006–2008 with catch of nil (solid line) and 15 million oysters (dashed line), under assumptions of (a) no disease mortality, (b) disease mortality of 0.20 $y^{-1}$, and (c) disease mortality of 0.40 $y^{-1}$.**

## (d) Other factors

### i) Continuing mortality from *Bonamia exitiosa*

Mortality from infection by *B. exitiosa* is the principal driver of oyster population dynamics in Foveaux Strait. Since the present *Bonamia exitiosa* epizootic began in 2000, surveys of the oyster population found all areas with high densities of recruited oysters including the designated commercial areas had a high prevalence of infection, and all areas had some high intensity patches of infected oysters within or near them. By October 2002, mortality from *B. exitiosa* infection had reduced both the numbers of commercial fishery areas and the oyster densities within them; mortality of oysters from 1999–2002 has reduced the oyster population in designated commercial fishery areas to one-third of the population in 1999. Between October 2002 and January 2005, large numbers of pre-recruit oysters entering the fishery have exceeded mortality from *B. exitiosa* infection.

Infection by *B. exitiosa* in oysters sampled at 40 stations in February 2006 showed the distribution of infection was more widespread compared with January 2005. Although prevalence (the percentage of infected oysters in a sample) of infection was similar to January 2005, intensity of infection (in infected oysters only) has increased. Mortality based on the number of oysters sampled with category 3+ infections and oyster densities estimated from limited sampling in commercial strata in February 2006 was expected to reduce the recruited oyster population from 242 million oysters (95% CI 145–377) to 228.2 million (135–357) by the beginning of the 2006 oyster season. How the prevalence and intensity of infection may change before the oyster season cannot be determined.

Examination of fishing patterns and the spread of prevalence and intensity of infection show no direct link between fishing and infection, and the factors that influence infection are global and possibly environmental.

## 6. STATUS OF THE STOCKS

Since 2004, model projections of recruit-sized stock abundance have been used for Foveaux Strait oyster stock assessment. In 2005, model estimates of population size were similar to those from the population survey. While uncertainty exists in levels of future recruitment and continued *B. exitiosa* related mortality, projections from the Foveaux Strait oyster stock assessment model indicate that current catch limits are unlikely to have any significant impact on future stock levels. Instead, future disease mortality will determine future stock status. Depending on the level of assumed disease mortality, projected status in 2008 ranged from about 80% more than the current level (with nil disease mortality) to about 80% of the current level (assuming disease mortality of 0.4 $y^{-1}$). The estimated level of *B. exitiosa* mortality from the February 2006 survey suggest the fishery may begin to rebuild given the current catch limits, and with mean catch rates likely to be around 2 sacks per hour.

**Table 12: TACC (number in millions) and landings (number in millions) of oysters from OYU5 for the most recent fishing year**

| Fishstock | Catch limit | Reported landings 2004-05 |
|---|---|---|
| OYU 5 | 14.95 | 7.57 |

## 7. FOR FURTHER INFORMATION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