UPDATE April 2005: ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT, THE FOVEAUX STRAIT CASE STUDY

It has been a busy start to the research year with the Foveaux Strait oyster and bonamia surveys in late January-early February, oyster stock assessment in March, and implementing a number of research programmes before the commercial oyster season got underway on Easter Monday. These programmes included establishing a pilot trial for shell return, sampling the size structure of oysters landed in the commercial catch, developing a programme to monitor spat settlement, and continuing to refine the data recorded by fishers for management. This update will present a brief overview of these investigations and summaries of results.

Surveys of the Foveaux Strait oyster population and bonamia infection

Background

Continuing oyster mortality from bonamia since 2000 has reduced the oyster population size, the number and size of commercial fishery areas, and the oyster density within them. The distribution of fishing effort shifted from western and central areas initially affected by bonamia to eastern Foveaux Strait between 2001 and 2002, where it has been focused since then. Information on the status of fishery, bonamia infection, and rebuilding of fishery areas affected by bonamia during 2000–04 is required for management. Because of the low population levels and oyster densities, the oyster population survey scheduled for October 2004 was deferred to January 2005 and combined with sampling to determine infection from bonamia. The January survey objectives were to:

- estimate bonamia infection
- estimate the population size of oysters in three size groups; legal sized oyster (recruits), medium sized oyster that would grow to legal size within two year (pre-recruits), and small oysters 10–50 mm in length
- estimate the commercial population size in designated fishery areas
- describe the distribution of oysters
- investigate rebuilding in commercial fishery areas 2000–04 (recruitment)
- estimate the numbers of oysters available for harvest (recruit size oyster stock abundance) using the Foveaux Strait oyster stock assessment model.

Results

The combined surveys were completed in ideal weather over late January-early February. There was a significant reduction in bonamia infection throughout the fishery. Infection was low and patchy – probably a result of low oyster densities limiting the ability of infective particles shed by dying oysters to infect other oysters. Oyster population levels were similar to those estimated in October 2002, and oyster density had remained low. The low oyster population levels and oyster densities do not appear to have affected the recruitment of small oysters.

Estimates of population size

Table 1 shows estimates of population size for legal sized (recruits), medium (pre-recruits), and small oysters. Figure 1 shows estimates of population size since 1990.

Table 1: Population estimates of oysters (millions) within the Foveaux Strait fishery area (1054 km^2). Recruited oysters (58 mm in length and greater), pre-recruit oysters (50–57 mm in length), and small oysters (10–49 mm in length); 95% confidence intervals in parentheses.

Survey	Recruits	Pre-recruits	Small
1999 (October)	1 461 (872–2334)	899 (570–1387)	1 373 (874–2115)
2001 (October)	995 (632–1511)	871 (548–1330)	1 410 (884–2156)
2002 (October)	502 (310–785)	520 (333–795)	1 243 (806–1884)
2005 (January)	408 (253–628)	414 (247–652)	1 344 (845–2056)

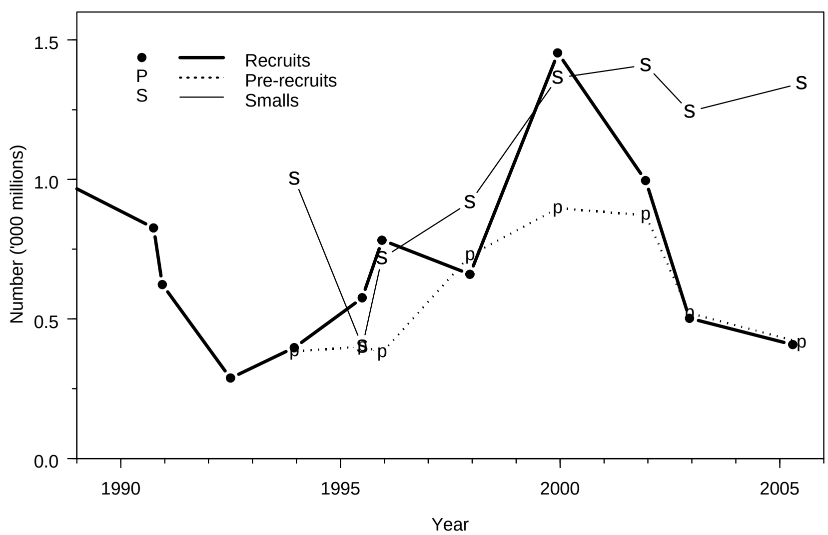

Figure 1: Population estimates for recruit, pre-recruit, and small from surveys 1990–2005. Data points are offset to represent month of sampling (January, March, and October).

Estimates of population size of recruited and pre-recruit oysters are similar to those in October 2002. Recruitment into these two size groups over the last two years has equalled or exceeded mortality from bonamia. Pre-recruits have declined in similar proportions to recruited oysters, suggesting that this size group may be as vulnerable to mortality from bonamia infection as recruit size oysters. Recruitment does not appear to be affected (at this stage) by the high recruit and pre-recruit oyster mortalities decreasing oyster densities to low levels. The population size of small oysters has not changed since pre-disease levels in 1999 (see Table 1). The distribution of small oysters has changed and there is some evidence of rebuilding in central and western areas. There has been no change in the estimate of commercial population size on which the TACC is based.

Bonamia infection

Forty of the 80 survey stations sampled with the highest densities of recruit sized oysters were examined for bonamia infection. Both the prevalence (numbers of infected oysters in the samples) and intensity of infection has decreased significantly from January 2004. There was no detectable bonamia infection in 16 of 40 stations examined, and more than half of the infected stations had one infected oyster in the sample (4%). Infection was widespread, but patchy.

Based on the small numbers of oysters with moderate to intense infections (less than 2% of 977 oysters examined for bonamia infection had category 3+ infections), little disease mortality is expected over the summer. How the prevalence and intensity of infection may have changed before the oyster season began could not be determined. Very few new clocks (the shells of recently dead oysters or gaping (dying) oysters were sampled in January 2005, indicating low mortality before to the survey.

Stock assessment

Since 2004, a mathematical model of the Foveaux Strait oyster population that uses historical data on oyster production (population size, size structure, recruitment, growth, and mortality) and fishing (total catch and catch rates) has been used for stock assessment. This model makes projections of recruit-sized stock abundance, that is, estimates of the numbers of oysters available to fishers over the next three years given assumptions of disease mortality from bonamia and total catch. 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 bonamia related mortality, projections from the stock assessment model indicate that current catch levels are unlikely to have any significant impact on future stock levels. Instead, future disease mortality, primarily from bonamia, 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 no disease mortality) to about 80% of the current level (assuming disease mortality of 40% a year) (Figure 2).

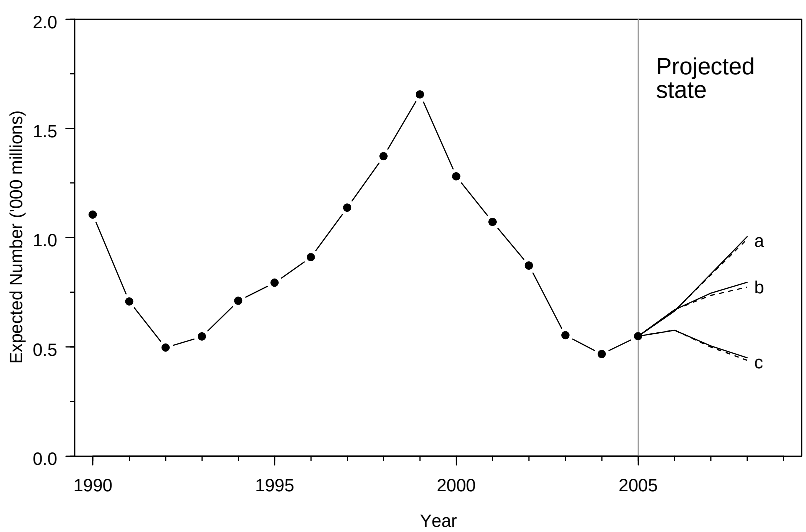

Figure 2: Model estimates of recruit-sized stock abundance and projected stock abundance for 2006–2008 with catch of nil (solid line) and 15 million oysters (dashed line), under assumptions of (a) no disease mortality, (b) disease mortality of 20% per year, and (c) disease mortality of 40% per year.

Shell return pilot trial

Background

Seabed habitat in Foveaux Strait can regenerate relatively quickly in the absence of dredging. The speed of regeneration can be increased by returning oyster shell to fished areas. Preliminary observations of a shell reef established by fishers showed promise: it provided good habitat for the settlement and survival of a diverse range of plants and animals, including oysters and blue cod. Plants and animals on the oyster shells promoted regeneration of a biogenic (living) reef, and oyster spat on the shells enhanced natural settlement of oysters. The diversity of benthic organisms on this shell reef increased significantly within 30 months, from freshly returned shell to a diverse biogenic reef of sea squirts, sponges, shellfish (including oysters), starfish, and urchins, surrounded by fish, mainly blue cod with some tarakihi.

A pilot trial to investigate shell return as a strategy to remedy the effects of dredging, and to boost production of oysters and blue cod by providing habitat for larval settlement and juvenile survival, began in March. The pilot trial will allow operational and scientific methods to be evaluated. It will also provide some quantitative data on changes to oyster and blue cod production, and the regeneration of seabed habitat that will be measured in a robust scientific manner. The pilot trial will investigate:

1. Oysters
    a. The survival of oyster spat and small oysters ("wings") on returned oyster shell,
    b. Shell return as a strategy for increasing settlement surfaces, oyster settlement, and juvenile oyster survival.

2. Enhancement of blue cod stocks
    a. Patterns of larval settlement and survival of juveniles, and the immigration of larger blue cod onto shell reefs,
    a. Patterns of size dependent emigration of blue cod after dredging.

3. Regeneration of biogenic reefs
    a. The roles of plants and animals on oyster shell in habitat regeneration and structure,
    b. Patterns of regeneration, colonisation, and the over-settlement of larvae in the water,
    c. Downstream regeneration of the seabed from shell reefs.

Based on the results of this trial, fishery-scale investigations of shell return are proposed and may test strategies specifically developed to enhance benthic habitat, existing oyster and blue cod populations, or establishing new oyster and blue cod populations on suitable habitats.

Resource consent was granted for two study sites in Foveaux Strait (Table 2 and Figure 3) subject to the investigation being carried out in a structured scientific manner and with regular reporting. Baseline surveys were conducted in these two areas in late March 2005 using underwater video systems. One site (Area 2) was chosen for the initial pilot trial. The area was divided into 9 sub-areas. Three of these are being stocked with freshly opened shell during the oyster season, three will be stocked with weathered shell just before the peak oyster settlement period in early summer, and three will remain empty as controls so that we can measure the effectiveness of fresh and weathered shell. We will sample these areas using underwater camera systems four times a year and take samples by diving in the autumn. The first survey is scheduled for mid May. We will investigate whether shell returned to the three areas has remained within the area boundaries and determine the structure and extent of the shell patches.

<u>Bluff oyster boat skippers, customary, and non-commercial/recreational fishers are requested to stay out of the two areas shown in Figure 3.</u>

Table 2: Area boundary corner positions for the two oyster shell and spat return areas for which resource consent has been granted.

Area 1				**Area 2**			
	Latitude		Longitude		Latitude		Longitude
Degrees	Minutes	Degrees	Minutes	Degrees	Minutes	Degrees	Minutes
46	41.8	168	16.0	46	40.2	168	20.4
46	42.6	168	15.4	46	40.5	168	19.8
46	43.2	168	17.2	46	41.4	168	20.4
46	42.6	168	17.6	46	41.0	168	21.2
46	41.8	168	16.0	46	40.2	168	20.4

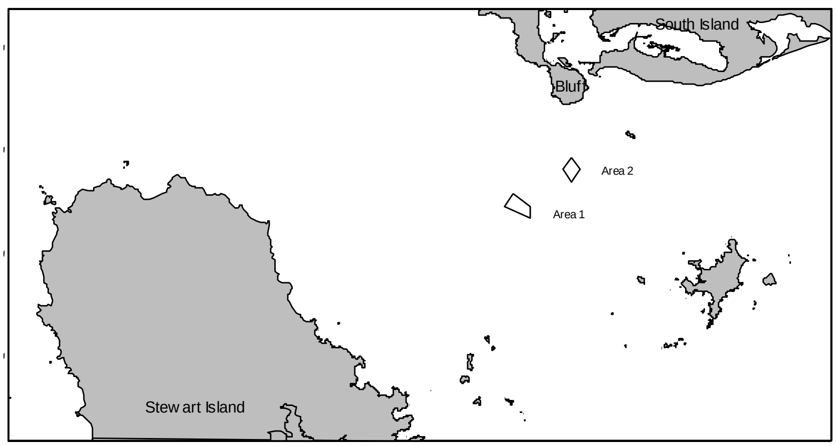

Figure 3: Location of shell return areas.

Results of baseline surveys

Both shell return areas were sampled using video with lasers for scaling. Downward-facing video was used to describe seabed habitat composition and structure, obliquely angled video for fish counts and larger-scale habitat descriptions, and dredge sampling to estimate oyster density and habitat composition from bycatch.

Few fish were seen on the obliquely angled video transects, a few spiny dogfish and a single blue cod. Both areas were flat, mainly sand and shell, Area 2 showing more fine gravels. The absence of blue cod and abundance of spiny dogfish reflects the lack of structure and habitat on the seabed. Both areas were fairly similar, but Area 1 was a little more variable, possibly due to remnants of the original shell reef that had been dredged a few years ago.

Views of the seabed from the downward-facing video camera showed a similar scene in both areas. Large expanses of flat featureless sand, shell, and pea gravel substrate with very little structure and very few patches of reef.

Dredging confirmed low densities of oysters in both areas, with Area 2 the lower; fewer than 20 recruit-sized oysters caught in each of three standard survey tows. Densities of pre-recruit oysters were similar, but small oysters were slightly higher. The bycatch composition was very similar from both areas. The substrate was shell, shell hash and sand, but Area 2 had pea gravel and bryozoan hash as well. Bycatch composition was also similar, comprising of starfish (including 5 fingers and 8 arm starfish), urchins (including kina), mussels (mainly three species), crabs, fan scallops, sea fans, and corals.

Both areas are suitable for shell return experiments and Area 2 was chosen for the initial pilot because of its low oyster density and more consistent expanses of flat, featureless seabed.

Other investigations

The Bluff Oyster Management Company will sample commercial catch for the size structure of landed oysters, and numbers of spat and wings that could not be removed by fishers. Size structure data will be used to update the Foveaux Strait oyster stock assessment model. Numbers of spat and wings will be used to estimate the number of small oysters returned to sea during the shell return trial and to investigate these data as an index of recruitment.

A better understanding of the dispersal and availability of oyster larvae for settlement over the oyster fishery area may provide important information for small spatial scale management of the fishery, and the relationships between discrete patches of oysters. The availability of larvae for settlement has important implications for enhancement of commercial populations through shell return strategies, and could determine whether brood stock would be required to establish new populations in areas enhanced with oyster shell. This year we will investigate the effectiveness of spat collector systems deployed from oyster vessels, and begin monitoring the distribution and timing of spat settlement. This project will investigate the range of larval dispersal from high density populations, investigate whether recruitment is settlement surface limited, and, most importantly, identify areas of high potential oyster production.

We will also continue to refine the data recorded in fishers' logbooks and investigate systems for automated or easy data acquisition. The data required for management will continue to be reviewed, and we will attempt to establish reliable indicators of oyster population levels, disease status, and habitat regeneration from the catch and bycatch. This investigation will be ongoing, informed by the results of research programmes.

Keith Michael
Alistair Dunn
Jeff Forman
Glen Carbines
05 April 2005