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Annual survey of the Foveaux Strait oyster (*Ostrea chilensis*) fishery (OYU 5) and *Bonamia exitiosa* prevalence, intensity, and disease mortality in February 2025

New Zealand Fisheries Assessment Report 2026/16

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- Annual research surveys monitor both oyster abundance within the fishery and the prevalence of Bonamia infection annually.
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- Oyster densities have declined since 2021.
- In 2025, 1752 oysters were tested from 71 stations, with 20.7% testing positive for Bonamia.
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EXECUTIVE SUMMARY

Morrison, M.A.[1]; Lane, H.S.; Bian, R.; Moss, G.; Brooks, A.; Smith, L; Forman, J. (2026). Annual survey of the Foveaux Strait oyster (*Ostrea chilensis*) fishery (OYU 5) and *Bonamia exitiosa* prevalence, intensity and disease mortality in February 2025. *New Zealand Fisheries Assessment Report 2026/16.* 47 p.

The Foveaux Strait oyster fishery (OYU 5) is a high value, nationally important fishery. A defining feature of the OYU 5 fishery is the recurrent infection by the haplosporidian parasite *Bonamia exitiosa*. The abundance of recruit-sized oysters and future harvest levels are primarily affected by *B. exitiosa* mortality. Fisheries New Zealand, therefore, monitors both oyster abundance within the fishery and the prevalence of infection from *B. exitiosa* in annual surveys. The information on the prevalence and intensity of infection and abundance of oysters can assist in annual harvest strategy decisions. The aims of the 2025 survey were to: (1) estimate the abundance and biomass of oysters in OYU 5; and (2) evaluate infection prevalence and intensity of *B. exitiosa* in OYU 5.

The latest annual monitoring survey was undertaken in February 2025, in collaboration with the Bluff Oyster Management Company Ltd on FV *Golden Harvest*. The data showed that oyster abundance continues to decrease for three of the four oyster size classes, with a slight increase in small oysters.

Oysters (n = 25 from each station) were tested for *B. exitiosa* using two different methods: (1) DNA-based *B. exitiosa* specific ddPCR; and (2) visually examined heart imprints. All oysters were tested with the ddPCR, however, only ddPCR-positive oysters and 2–3 ddPCR-negative oysters per station were examined by heart imprints.

In total, 1752 oysters were tested from 71 stations, with 363 (20.7%) testing positive for *B. exitiosa* via ddPCR and 11.3% of oysters testing positive via heart imprints. The prevalence of infection in 2025 was higher than in both 2024 (18.1%) and 2023 (8.7%) and the highest it has been since at least 2015. The infection intensity has increased in step with prevalence of infection, with more widespread fatal infections detected, particularly in the central parts of the fishery. There was also an increase in the proportion of non-fatal infections, indicating ongoing parasite transmission driven by dying oysters shedding high numbers of parasites.

Infection was widespread with very few stations with no detectable infections and few stations without fatal infections. The increase in infection prevalence and intensity plus the number of new clocks combine to produce an estimated 2025 summer mortality between 12.1% and 12.3%, which is an increase from 10.2–10.6% in 2024, 7.4% in 2023 and 4.9% in 2022. Summer mortality has not been estimated to be this high since around 2015.

Oyster densities continue to decline in the Bonamia survey area, a decline that started in 2021. The downward trajectories of all four size classes are very similar from 2021 to 2025, although since 2023 small sized oysters have remained at a stable abundance. The increased prevalence of infection, including fatal and non-fatal infections, is expected to continue to impact the number of recruited oysters in the population.

[1] Earth Sciences New Zealand Ltd (formerly National Institute of Water and Atmospheric Research Ltd)

1. INTRODUCTION

The Foveaux Strait oyster fishery (OYU 5) is a high value, nationally important fishery that has been fished for over 150 years. Flat oysters, also known as dredge oysters (*Ostrea chilensis*), are a valuable customary (taonga), recreational, and commercial species, playing a significant role in the socioeconomics of Bluff and Invercargill. The OYU 5 stock is part of the Group 1 stocks in the Fisheries New Zealand draft National Fisheries Plan for Inshore Shellfish (Ministry of Fisheries 2011), which recognises their relatively high biological vulnerability and prescribes a close monitoring approach. Achieving maximum value from Group 1 stocks is best done through accurate and frequent monitoring to support responsive management.

A defining feature of the OYU 5 fishery is the recurrent infection by the haplosporidian parasite *Bonamia exitiosa*. First detected in 1986 (Dinamani et al. 1987), the parasite swept through oyster beds, causing mortality that reduced the population to around 10% of its pre-disease level (Cranfield et al. 2005). *Bonamia exitiosa* is now endemic in the Foveaux Strait, and infection, and associated mortality, remain the principal driver of oyster population abundance. Significant biomass reductions due to bonamiasis were observed in the early 2000s and from 2012 to 2016 (Dunn et al. 2002a, Michael et al. 2015), and the cyclical nature of heightened mortality suggests that future epizootics are likely.

Recruited oysters (≥ 58 mm) are the most susceptible to bonamiasis because parasite replication is closely linked to the gametogenesis of the oyster host and its transition from predominantly male to female gonads, which typically occurs as oysters reach larger sizes (Hine 1991). Clinical signs of infection are rare, and the first indication of infection is often death, marked by empty oyster shells (known as "clocks") – the articulated shells of recently dead oysters. Because the abundance of recruited stock and future harvest levels are primarily affected by *B. exitiosa* mortality, Fisheries New Zealand monitors both oyster abundance within the fishery and the prevalence of infection. Knowledge of infection prevalence and oyster abundance supports informed decisions on annual harvest strategies.

Annual surveys, hereafter referred to as Bonamia surveys, monitor the status of the oyster population and its associated level of *B. exitiosa* infection. Bonamia surveys are conducted four out of every five years, with the fifth year receiving a larger area 'stock assessment survey' that encompasses all of Foveaux Strait's past and present oyster fishing areas. This larger survey uses a well-established 26 strata stratification that has not changed since 2012, and is run as a two-phase, random stratified survey. The Bonamia survey (also a two-phase random stratified survey) focusses on the core commercial fishery area, using 14 of the stock assessment survey's 26 strata. The remaining 12 strata are combined into one larger background 15th stratum for the Bonamia survey, which receives low sampling effort (five stations). This makes the Bonamia and stock assessment surveys match in their spatial extents. Both surveys classify oyster size into four bins, using physical steel rings (50, 58, and 65 mm internal diameter) to determine whether an oyster can pass through each ring.

As well as tracking oyster abundance and upcoming recruitment ('medium (pre-recruit)' size class) over time for stock assessment purposes, the survey data (collected in February) also provide a useful forecast for the following oyster season (starting March) as oyster density and meat quality determine commercial catch rates and fisher's spatial fishing strategy. This information is used by fishers to assess prospects for the up-coming oyster season.

The survey also estimates the prevalence and intensity of Bonamia infection and short-term (summer) mortality in recruited oysters. Infection prevalence and intensity is measured via *B. exitiosa*-specific droplet digital Polymer Chain Reaction (ddPCR) and cytology, i.e., heart imprints. These test data are combined with the survey estimates of oyster densities and population sizes (for each of the four size classes), and clock densities, to provide an estimate of both summer mortality (using new clocks) and overall mortality (old clocks) caused by *B. exitiosa*.

This Fisheries Assessment Report (FAR) summarises the 2025 Bonamia survey results, the most recent in the long time series of surveys on the status of *B. exitiosa* in the flat oyster Foveaux Strait fishery (OYU 5). This survey was undertaken as part of Fisheries New Zealand research programme OYS2023-01. Sampling was undertaken in collaboration with the Bluff Oyster Management Company Limited, who provided the survey vessel, the OYU 5 survey dredge, and crew to assist the survey.

1.1 Objectives

Overall objectives

1. To evaluate the current abundance and biomass of oysters in the OYU 5 fishery and to evaluate current and expected oyster mortality from Bonamia infection for the fishing years 2023, 2024, and 2025.
2. To evaluate the current status of the prevalence and intensity of Bonamia in the OYU 5 fishery for the fishing years 2023, 2024, and 2025.

Project objectives

1. Using a stratified random sampling design, estimate the current recruited abundance and biomass of oysters within the area of the commercial Foveaux Strait oyster fishery, with a target CV of ≤ 20%.
2. Using a stratified random sampling design, estimate the annual mortality from Bonamia within the area of the commercial Foveaux Strait oyster fishery.
3. Using a stratified random sampling design, estimate the prevalence and intensity of Bonamia within the area of the commercial Foveaux Strait oyster fishery.
4. Review all ddPCR procedures prior to undertaking any analysis of tissue samples at the beginning of each fishing year's survey.
5. To sample the commercial catch for length data during the 2023, 2024, and 2025 fishing years.

Specific objectives for the February 2025 survey

1. Estimate oyster density and population size for four size groups (pre-recruit, recruit, large, extra-large) in the stock assessment and Bonamia survey areas.
2. Estimate the prevalence and intensity of *Bonamia exitiosa* infection in recruit-sized oysters using ddPCR and heart imprints to maintain the long time series of infection data.
    a. Undertake pre-testing checks on all ddPCR procedures and reagents.
    b. Estimate summer mortality combining two different estimates of mortality:
        i. Pre-survey mortality, the population size of recruit-sized new clocks and gapers.
        ii. Projections of post-survey mortality from oysters with fatal infections (category 3–5 infections).

2. METHODS

2.1 Station allocation

The 2025 Bonamia survey was conducted in the whole OYU 5 stock assessment survey area (Figure 1). The Bonamia survey strata were the same as for previous Bonamia surveys since 2014, with the surrounding stock assessment survey strata merged into a single, large background 'BK' stratum (Figure 1). Using the 2014 strata polygons, the stratum areas were recalculated using R (R Core Team, 2024).

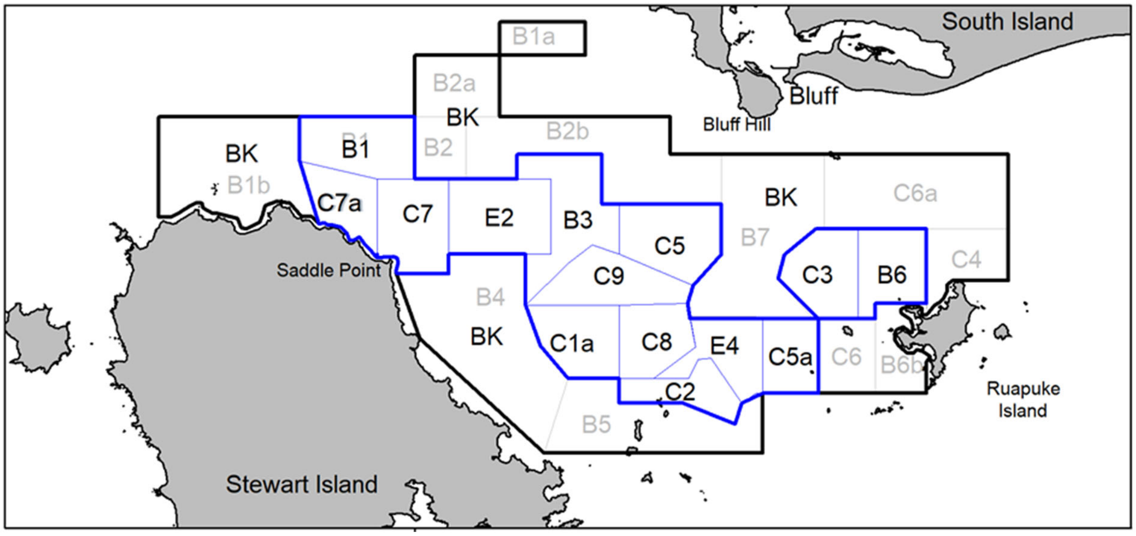

Figure 1: The stock assessment survey area outer extent is shown with a thick black line, with its 12 strata collapsed into one background stratum (BK) for Bonamia surveys. Nested within this BK stratum is the Bonamia survey area (in blue), which holds 14 strata.

Fifty-five stations were available within the Bonamia survey area: fifty in the first phase, and five in the second phase. Each stratum initially contained three first-phase stations, with the remaining eight stations sequentially assigned to the strata providing the greatest predicted coefficient of variation (CV) reduction. Those strata were selected using the 2024 survey data with the software function '`allocate`' (Francis 2006) within the R package '`SurvTools`' (developed by NIWA). Overall, a CV of approximately 11% was predicted for the Bonamia survey. A fixed allocation of five stations was assigned to the background BK stratum.

The '`get.random.stations`' function from `SurvTools` was used to randomly generate the locations of first-phase stations and second-phase stations in the Bonamia survey strata (hereafter referred to as core strata), and stations in the background stratum. The random station locations were generated with an exclusion distance of 0.75 nautical miles to ensure good spatial coverage and prevent sample tow overlap within strata. No distance constraint was applied to the distances between stations and stratum boundaries.

Three months prior to the survey, the potential station locations list was sent to Stephen Hawke, the skipper of the survey vessel, who identified those stations that would be un-dredgable due to foul ground. Each of those stations was discarded and replaced with the next available station down the list (Table 1, Figure 2).

A further 12 fixed stations, unchanged from 2015 onwards, were also allocated survey time. Those stations (T-series) were established to provide a time series of changes in oyster density and Bonamia status in localised areas.

Table 1: The number of first-phase, second phase, and fixed (T-series) stations sampled, and the area of each stratum for the February 2025 Bonamia survey. A single, large background stratum (BK) represents the merged stock assessment survey strata outside the Bonamia survey area (see Figure 1).

Stratum	First phase	Second phase	Fixed stations (T-series)	Stratum area (km^2)
B1	3		1	78.2
B3	6			44.7
B6	3			30.0
C1a	4	3	2	31.3
C2	3			21.9
C3	3		1	32.7
C5	3		1	37.7
C5a	3		1	23.5
C7	3		1	36.1
C7a	3			23.6
C8	3	2	1	26.8
C9	3			34.5
E2	7		2	42.8
E4	4		2	28.0
BK	5			578.3
Total	50	5	12	1 070.1

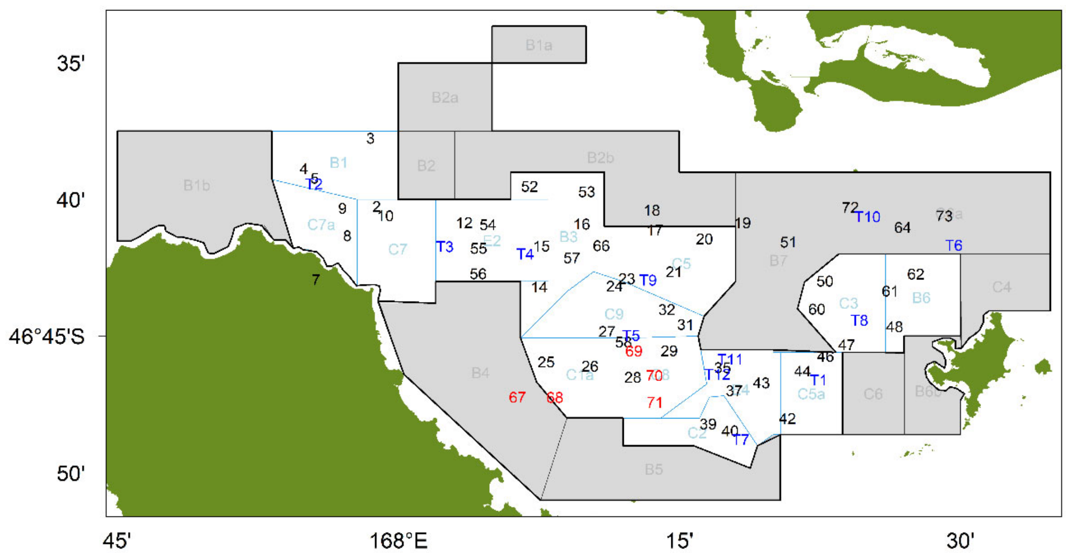

Figure 2: The 2025 survey design with the area of each Bonamia survey strata shown as fine blue lines, with the surrounding BK stratum shaded grey. First-phase station numbers are in black text, second phase in red text, and fixed (T-series) stations in blue text.

2.2 Catch sampling

Details of the standardised procedures are given by Michael et al. (2015). Survey stations were sampled with the standard survey dredge (commercial dredge 3.35 m wide and weighing 430 kg). Each tow was 0.2 nautical miles, measured from when the dredge was on the bottom and the winch brake applied, to when the winch commenced hauling in. One oyster dredge tow was conducted at each station.

The catch from each tow was sorted into live oysters, gapers (live, but moribund oysters containing the whole oyster and valves remaining apart after the adductor muscle has lost its ability to contract), and clocks (the articulated shells of recently dead oysters with the ligament attaching the two valves intact) to estimate mortality. Reference rings (50 mm, 58 mm, and 65 mm internal diameter) were used to allocate each oyster to its respective size class (small, medium, large, extra-large).

Clocks and gapers were recorded for the medium and large size classes, and within those, new and old clocks. New clocks were defined as those with clean inner valves that had retained their lustre but may have had some minor speckling from fouling organisms. Old clocks were defined as shells that were fouled or in which the inner valves had lost their lustre and were often covered in fouling organisms on both external and internal surfaces. As the ligaments of oysters are thought to break down over about a three-year period, old clocks represent oysters that have died between one and three years previously (Cranfield et al. 1991). Additionally, newly dead oysters that still had some body tissue present, known as gapers, were also recorded (these were a subset of the new clock group).

The data recorded at each station included start and finish locations, depth, and speed of tow; numbers of oysters, new clocks, and gapers caught by size group; percentage fullness of the dredge; wind force (Beaufort scale); stations where live bryozoans (*Cinctipora elegans* and *Celloporina aggultinans*) were observed; and sediment type. The presence/absence of bycatch species was also recorded directly from the dredge contents.

2.3 Estimates of oyster densities and abundances

Oyster densities and population sizes for the four size groups of live oysters were estimated for the Bonamia survey area (14 core strata), the single background BK stratum (combining the 12 non-core strata), and all 26 survey strata combined (the stock assessment survey area). The densities and abundances and their uncertainties were estimated using a standard stratified random sampling method (Francis 1984, Jolly & Hampton 1990, Francis & Fu 2012).

The oyster density for each station was calculated by dividing the number of observed oysters in the station by the area swept by the dredge, which was the dredge width multiplied by the tow distance. Tow distance was the length of the straight line between the start point and end point of each tow, and in the case of missing either start or end point, a default distance of 0.2 nautical miles was used.

The mean density of each stratum was calculated by averaging the station densities within the stratum. Multiplying the stratum mean density by the stratum area produced the stratum abundance. The CV of a stratum abundance was calculated by dividing the standard error by the mean density of the stratum.

Stratum abundances were corrected using a dredge efficiency of 0.17, which was estimated by Dunn (2005) and used in previous Bonamia survey analyses (e.g., Michael et al. 2023a).

The population sizes of small, pre-recruit, recruit, and extra-large oysters, and new clocks were calculated from combining the stratum abundances. The equation below was used in the calculation of population size CVs.

$$CV = \frac{\left(\sum_{i=1}^{n} a_i^2 s_i^2\right)^{0.5}}{n^{0.5} \sum_{i=1}^{n} a_i \bar{x}_i}$$

where n is the number of strata in the survey; a_i is the area of the ith stratum; $\bar{x}_i$ is the mean oyster density and s_i is the standard deviation in the ith stratum.

Associated 95% confidence intervals were calculated within SurvTools, by multiplying the standard errors by 1.96.

2.4 Estimates of commercial population size

In 1995 and 1997, Cranfield et al. (1999) estimated Current Annual Yield (CAY) from a "commercial population" that reflected the patchy distribution of oyster density. They defined the commercial population as the recruited population in the stock assessment survey area above a density of 400 oysters per tow (equivalent to about 6–8 sacks per hour during commercial dredging). This threshold was based on a historical, economic catch rate and when the catch rate dropped below 6 sacks per hour, fishers would move to new fishery areas. Although this method is no longer used for stock assessments, estimates of commercial population size allow some comparison with previous years and the Shellfish Working Group requested that these estimates be included in this report.

2.5 Recruitment estimated from dredge survey

Recruitment to the fishery was summarised using plots of changes in the population estimates of pre-recruit and small oysters and from changes in the patterns of distribution of small oyster densities between the February 2024 and February 2025 surveys.

2.6 Spatfall annual monitoring using deployed collectors

Ostrea chilensis larvae readily settle on manmade substrates, without conditioning, and in the absence of conspecifics. Counts of oyster spat that settled to passive, artificial collectors (November to February) represent densities of competent larvae ready to settle on natural surfaces. Artificial spat collectors, each with four collector plates, were set out in the field three months before the Bonamia survey. The first three stations in each stratum were selected as the collector deployment sites. Settler densities at each site were defined as the cumulative numbers of both living and dead oyster spat that settled on the top and bottom surfaces of the four plates, on retrieval of the spat collectors during the February survey. These series first began over the summer of 2014–15.

2.7 Sample processing for testing for *Bonamia exitiosa*

Randomly selected recruit-sized oysters (n = 30) from each station were flown to Earth Sciences New Zealand (Earth Sciences NZ), Wellington, where they were measured, shucked and dissected. Oysters were generally processed the day after arrival at the lab, with all oysters stored at 4°C until processing. The first 25 oysters from each station were processed for molecular testing and heart imprints. The remaining 5 oysters were stored until processing was completed for each station and then discarded if not required. All processed oysters were assigned to a size class, after which their length (anterior-posterior axis) and height (dorsal-ventral axis) were measured with callipers and recorded.

Before shucking, any gaping oysters were recorded. An oyster was classified as a gaper if it failed to close its shell in response to an external stimulus, e.g., tapping. Oysters were then shucked using sterile shucking knives to prevent cross-contamination. Between each oyster, the knives were rinsed in distilled water, soaked in bleach (2% sodium hypochlorite) for 3 minutes, and rinsed again in distilled water. Several shucking knives were used in rotation. After shucking, oysters were inspected for larval brooding, and the colour recorded as grey (R), white (W), or gold (G). Oysters were also graded for condition following Michael et al. (2023b; Appendix 1) and examined for signs of infection by the digenean trematode *Alcicornis (=Bucephalus) longicornutus* (Appendix 2).

The heart was extracted from each oyster using sterile forceps and then blotted on filter paper. The heart was then dabbed along the length of a clean pre-labelled microscope slide to create three rows of imprints. After this, the heart was placed into a pre-labelled 96-well plate for DNA extraction. The slides were stained using Hemacolour® following manufacturer's instructions. Additionally, three pieces of gill tissue, each approximately the size of a grain of rice, were excised from each oyster. Each piece of gill was placed into a separate pre-labelled sterile 96-well plate. All 96-well plates were stored frozen until required for DNA extraction.

Finally, a tissue section was taken from the first five oysters of each station and placed into a pre-labelled histo-cassette and fixed in 10% neutral buffered formalin. The tissue section was approximately 5 mm thick and aimed to capture all of the main oyster tissues, including gill, mantle, digestive structures, kidney, and gonad. All histological samples are archived at Earth Sciences NZ, Wellington.

2.8 ddPCR

Heart tissue from each of the 25 oysters from each station, was analysed for DNA extraction using a rapid digestion method. This consisted of adding 100 µL of lysis buffer (500 mM KCl, 200 mM Tris pH 8.0, 15 mM $MgCl_2$) and 100 µg of proteinase-K to each sample, followed by tissue digestion at 56ºC for 45 minutes with periodic shaking. A 1:20 dilution of this lysate was used for ddPCR testing.

All tissue lysates were tested using a *B. exitiosa*-specific ddPCR assay (Bilewitch et al. 2018). The assay includes an internal control targeting the oyster β-actin gene to confirm the presence of amplifiable DNA in each sample. Each 24 µL ddPCR reaction sample consisted of BioRad ddPCR Supermix, primers and probes, and 3 µL of the digested tissue lysate as template DNA. Droplet generation was automated using a BioRad AutoDG, followed by amplification on a BioRad CFX thermocycler and droplet reading on a BioRad QX200. Each plate included a positive control (synthetic *B. exitiosa* standard) and a negative control (molecular-grade water).

Samples with at least five positive droplets were considered positive for either *B. exitiosa* or oyster β-actin. Any sample with fewer than five positive droplets for the β-actin internal control was repeated; if the repeat also failed, gill tissue was used for DNA extraction and testing using the same method. From each sample, we determined: (a) the presence of *B. exitiosa*; and (b) the relative infection level; normalised by β-actin concentration to account for variations in the amount of starting DNA template in each ddPCR reaction. Infection prevalence at each station was calculated by the proportion of samples that tested positive for *B. exitiosa*.

2.9 Heart imprints

Heart imprints were examined for oysters that tested positive for *B. exitiosa* by ddPCR, as well as a random selection of around 2–4 oysters per station that tested negative. Not all *B. exitiosa*-negative oysters were examined, as ddPCR has greater analytical sensitivity than visual inspection, and negative ddPCR results were assumed to indicate absence of *B. exitiosa*. Stained heart imprint slides were examined by an experienced technician using an Olympus compound microscope. Each sample was scored according to a semi-quantitative scale (Diggles et al. 2003). *B. exitiosa*-negative samples were scored 0, light infections were scored 1 or 2, moderate infections were scored 3, and heavy to very heavy infections were scored 4 or 5. Scores of 1 or 2 were classified as non-fatal infections and scores of 3+ were classified as fatal infections. All heart imprint slides were archived at Earth Sciences NZ, Wellington.

2.10 Statistical analyses of prevalence and infection intensity

Differences in *B. exitiosa* 18S rRNA gene copy numbers among years (2022–2025) were tested using a negative binomial generalised linear model (GLM). This period corresponded to years in which increasing mortality was observed (Morrison et al. 2025). A negative binomial distribution was selected to account for overdispersion in the data. Estimated marginal means and associated 95% confidence intervals were obtained to compare mean gene copy numbers among years, and marginal plots were generated to visualise these estimates. All statistical analyses were conducted in R (v.4.4.2; R Core Team, 2024) using the MASS package (v.7.3-60.0.1) for fitting negative binomial GLMs, the emmeans package (v.1.11.2) for calculating estimated marginal means, and ggplot2 (v.3.5.2) for visualisation.

2.11 Estimates of fatal and non-fatal infections and annual mortality from bonamiasis

Bonamia surveys estimate the summer mortality of recruited oysters only. Summer mortality is calculated as the sum of two components: (1) pre-survey mortality, based on the number of newly recruited oysters and gapers that died over the summer; and (2) projected future mortality within approximately two months, estimated from the proportion of oysters with fatal infections (heart imprint scores ≥3) and scaled to the total recruited population. While pre- and post-survey mortality measure different variables – and pre-survey mortality may include natural (non-disease-related) deaths – the combined total provides the best estimate of summer mortality. Note that data from the fixed T-stations were excluded from estimates of population size, infection, and mortality related to *B. exitiosa*.

Two methods were used to scale fatal and non-fatal infections in recruit-sized oysters to population estimates. Estimates are presented by stratum and for the Bonamia and stock assessment survey areas.

Method 1 applied a correction factor, calculated as the proportion of fatally infected oysters still alive at the time of the survey in strata with three or more randomly selected stations (Dunn et al. 2002b). This correction factor reduced the estimated population size by the mean proportion of category 3–5 infections. Total projected mortality was then calculated as the difference between the total population at the time of the survey and the population corrected for projected *Bonamia* mortality

Method 2 used the number of oysters in each infection category determined via heart imprints (stages 1–5) to calculate the numbers of non-fatal and fatal infections per sample, which were then scaled to the total catch for each station. Overall infection intensity was calculated as the average infection level in the population. Variance for prevalence and intensity was estimated using standard methods applied to population estimates.

3. RESULTS

Sea conditions were good throughout most of the February 2025 survey period. Earth Sciences NZ and Bluff Oyster Management Company (BOMC) staff began the survey on the 7 February 2025 and finished on the 12 February 2025. During the five survey days, 67 stations were sampled using the oyster vessel F.V. *Golden Quest*. The locations of survey tows are shown in Figure 2 and the numbers of stations sampled in each stratum are given in Table 1.

3.1 Oyster abundance

Changes in oyster densities between 2024 and 2025, at the stratum level

Time series of oyster catches adjusted to the standard tow length (0.2 nautical miles) by stratum are shown in Figures 3–6. Dredge tow lengths were mostly a little under 0.2 nautical miles (371 m). Catches of all four size classes were spatially patchy and locally variable. Three stations returned kāeo (stalked ascidians) as bycatch, with generally few oysters across the four size classes. Putatively, dense stands of kāeo on the seafloor are likely to have greatly reduced dredge efficiency. Oyster density was most likely underestimated at these stations. Catches of oysters across all groups in the background stratum (BK) were generally lower than the core fishery area.

Average catch rates of extra-large oysters were highest in the central strata of E2 through C8, except for low catches in stratum C5 (Figure 3). Catches in the western and eastern areas were lower. This pattern was also apparent for the large and medium oyster catch rates (Figures 4 & 5) but were more consistent from west to east for small oysters (but see B6) (Figure 6).

Comparisons between 2024 and 2025 showed reduced catch rates of extra-large and large oysters for most of the strata; no increases in catch rates were seen between 2024 and 2025 except for in stratum E4 (Figures 3 & 4). Medium and small oysters showed little change in average abundances between 2024 and 2025, with the exception being small oysters in stratum E4, which increased (Figures 5 & 6).

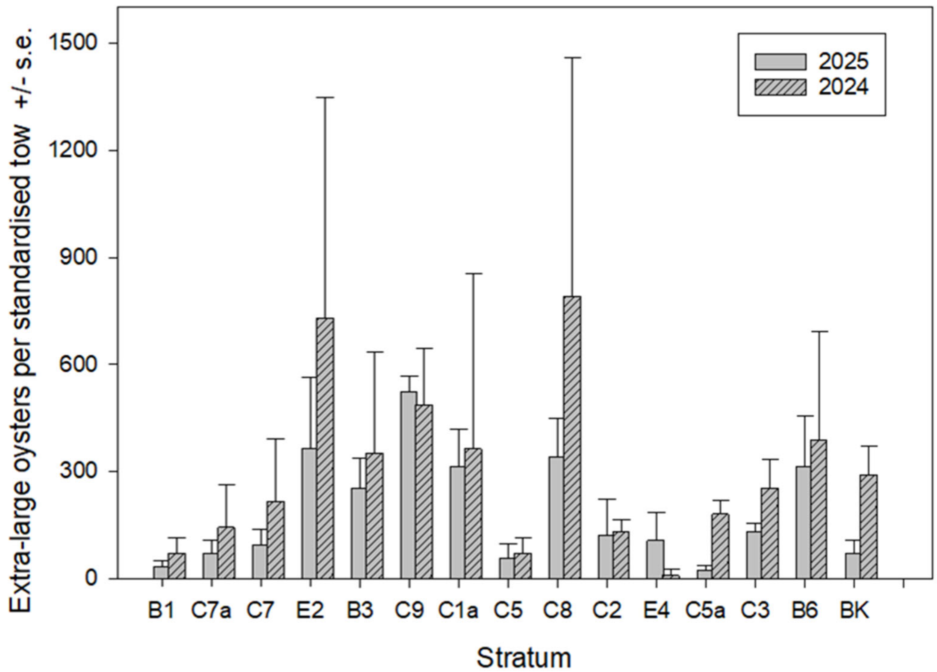

Figure 3: The average number of extra-large oysters (>65 mm diameter) +/- s.e., per tow, corrected for dredge efficiency, for the 2024 and 2025 surveys. Tow numbers are adjusted to a standard tow length of 0.2 nautical miles. Bonamia survey strata are arranged west to east, with northern strata at similar longitudes shown first, and the background stratum (BK) furthermost right.

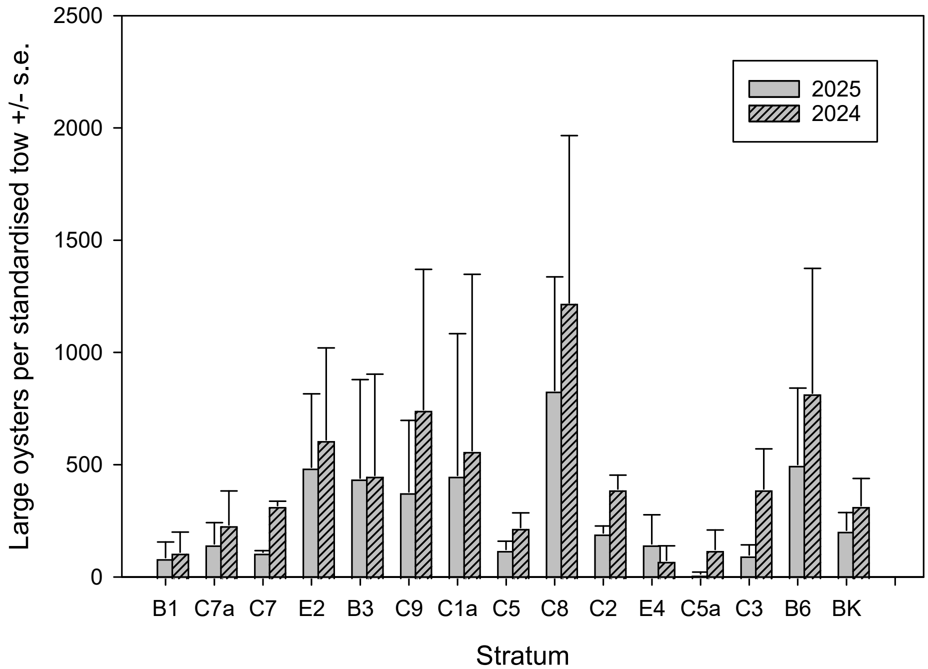

Figure 4: The average number of large oysters (58–65 mm diameter) +/- s.e., per tow, for the 2024 and 2025 surveys. Tow numbers are adjusted to a standard tow length of 0.2 nautical miles. Bonamia survey strata are arranged west to east, with northern strata at similar longitudes shown first, and the background stratum (BK) furthermost right.

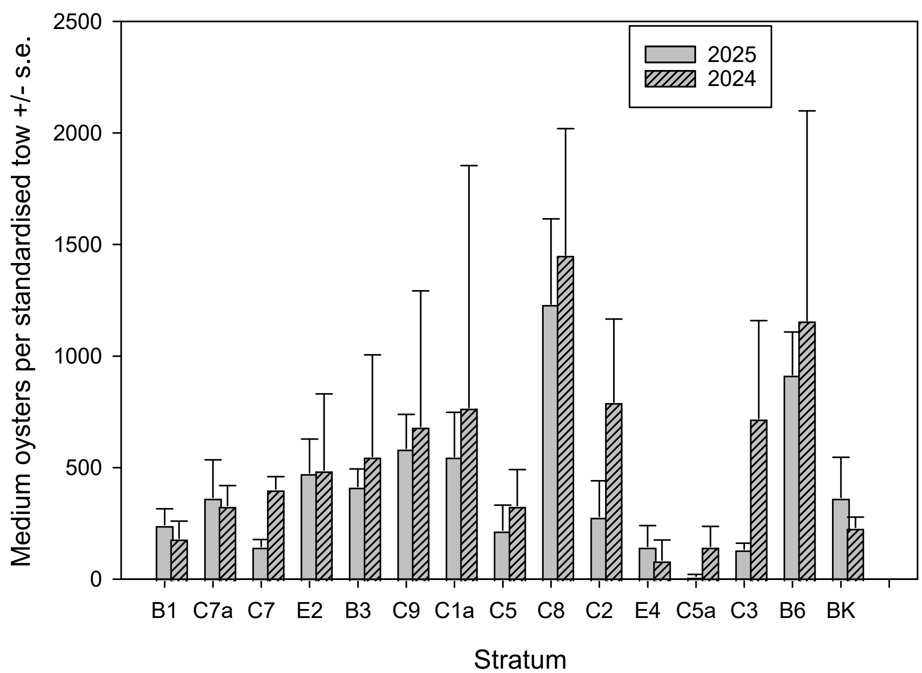

Figure 5: The average number of medium oysters (50–57 mm diameter) +/- s.e., per tow, for the 2024 and 2025 surveys. Tow numbers are adjusted to a standard tow length of 0.2 nautical miles. Bonamia survey strata are arranged west to east, with northern strata at similar longitudes shown first, and the background stratum (BK) furthermost right.

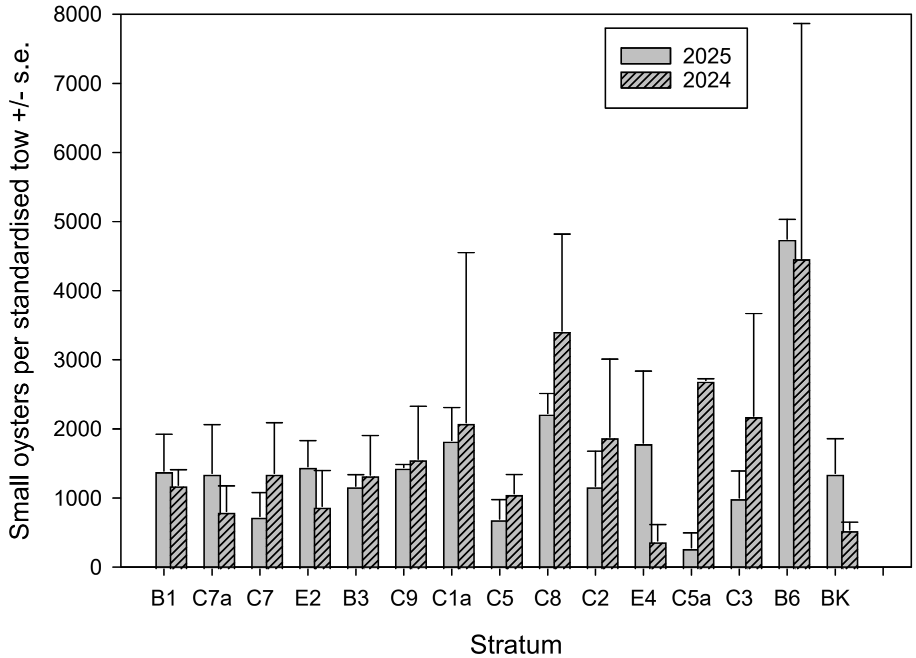

Figure 6: The average number of small oysters (<50 mm diameter) +/- s.e., per tow, for the 2024 and 2025 surveys. Tow numbers are adjusted to a standard tow length of 0.2 nautical miles. Bonamia survey strata are arranged west to east, with northern strata at similar longitudes shown first, and the background stratum (BK) furthermost right.

Survey estimates of population size

Estimates of true population size (i.e., corrected for dredge efficiency) for extra-large, large, medium, and small oysters from the February 2025 survey are given by stratum for the core strata (n = 14: B1, B3, B6, C1a, C2, C3, C5, C5a, C7, C7a, C8, C9, E2, and E4), all core strata combined, the background stratum (all background strata combined (BK), n = 12: B1a, B1b, B2, B2a, B2b, B4, B5, B6b, B7, C4, C6, and C6a), and the whole 2007 stock assessment survey area (Survey total) in Tables 2–5. For the Bonamia survey area only, population estimates and the percentage change in population size between years, for large, medium, and small oysters from the 2012 and 2016–2025 surveys, and for extra-large oysters from the 2019–2025 surveys are shown in Table 6. Mean population sizes and 95% confidence intervals for these four size groups for 2012 and 2014–2025 in the Bonamia survey area are shown in Figure 7, and for the larger assessment survey area in Figure 8.

Comparisons between the population estimates for the background stratum should be made with caution. The density of oysters in the background stratum is not well estimated in Bonamia survey years due to the low numbers of stations sampled (n = 5) over a large area (578.4 km^2).

Fishers high-grade their catches (return the smaller oysters that are above minimum legal size) to maximise the numbers of first grade (referred to here as extra-large) oysters. The density and population size of extra-large oysters were estimated for the first time in 2019 and represent the size group preferred by fishers. The population size of extra-large oysters has declined since 2021 from 405.6 million down to 75.9 million individuals in 2025, an 81% drop. Large and medium oysters also show this strong decline, with a very similar downward trajectory. Small oysters maintained their densities for a year longer to 2022 (with large error bounds), before also following the same downward decline in 2023, then have stabilised since (Figure 8).

No stations caught more than 400 harvestable oysters (extra-large and large oysters classes combined), compared to four stations in 2024 (range 446 to 592 oysters, each in a different stratum = C8, E4, B3 and E2; Morrison et al. (2025)).

Table 2: True population estimates for extra-large (≥65 mm in diameter) oysters by stratum, the background stratum (BK), the Bonamia survey area (Core), and the full stock assessment survey area (All). All numbers corrected to true values using a dredge efficiency of 0.17. Shown are the number of stations (No. stations), mean oyster density (per m^2), coefficient of variation (CV), estimated 2025 population size (2025 popn. in millions, blue shaded), and 95% CI's, estimated 2024 population size (2024 popn., grey shaded), and % change from 2024 to 2025 (orange for decrease, green for increase).

Stratum	No. stations	Mean density per m^2	Density CV	2025 popn.	lower 95%	upper 95%	2024 popn.	% change
B1	3	0.03	0.38	1.2	0.3	2.0	2.2	-45
C7a	3	0.06	0.49	2.1	0.1	4.1	2.7	-22
C7	3	0.08	0.41	1.8	0.4	3.2	6.6	-73
E2	7	0.30	0.54	12.8	-0.7	26.4	25.6	-50
B3	6	0.21	0.31	9.3	3.7	15.0	12.7	-27
C9	2	0.43	0.08	14.6	12.5	16.8	13.8	6
C1a	3	0.26	0.32	8.2	3.1	13.3	9.4	-13
C5	3	0.05	0.59	1.7	-0.3	3.7	2.1	-19
C8	3	0.28	0.31	7.5	2.9	12.0	17.2	-56
C2	3	0.10	0.82	2.3	-1.4	5.9	2.3	0
E4	4	0.09	0.69	2.6	-0.9	6.1	2.0	30
C5a	5	0.02	0.53	0.4	0.0	0.8	3.5	-89
C3	5	0.11	0.15	3.6	2.5	4.6	6.8	-47
B6	3	0.26	0.44	7.8	1.0	14.7	9.4	-17
BK	5	0.06	0.47	38.0	2.8	73.3	114.5	-67
Core	50	0.17	0.06	75.9	57.2	94.7	114.5	-34
All	55	0.11	0.07	113.9	74.0	153.9	263.9	-57

Table 3: True population estimates for large (≥ 58 mm to <65 mm in diameter) oysters by stratum, the background stratum (BK), the Bonamia survey area (Core), and the full stock assessment survey area (All). All numbers corrected to true values using a dredge efficiency of 0.17. Shown are the number of stations (No. stations), mean oyster density (per m^2), coefficient of variation (CV), estimated 2025 population size (2025 popn. in millions, blue shaded), and 95% CI's, estimated 2024 population size (2024 popn., grey shaded), and % change from 2024 to 2025 (orange for decrease, green for increase).

Stratum	No. of stations	Mean density	Density CV	2025 popn.	lower 95%	upper 95%	2024 popn.	% change
B1	3	0.07	0.82	2.4	0.5	4.4	3.3	-27
C7a	3	0.12	0.65	4.4	0.5	8.2	4.6	-04
C7	3	0.09	0.06	2.2	0.8	3.6	9.3	-76
E2	7	0.40	0.67	16.9	2.3	31.6	21.3	-21
B3	6	0.36	1.00	16.1	7.1	25.2	16.3	-01
C9	2	0.31	0.84	10.4	1.2	19.7	20.9	-50
C1a	3	0.37	1.40	11.4	3.7	19.1	14.2	-20
C5	3	0.10	0.30	3.8	-0.5	8.2	6.6	-42
C8	3	0.68	0.61	18.2	5.6	30.7	26.7	-32
C2	3	0.16	0.16	3.4	-1.0	7.8	6.9	-51
E4	4	0.12	0.89	3.3	-1.3	7.9	1.7	94
C5a	5	0.01	0.71	0.1	0.0	0.3	2.3	-96
C3	5	0.08	0.46	2.6	0.9	4.3	10.4	-75
B6	3	0.41	0.68	12.3	4.9	19.7	19.9	-38
BK	5	0.17	0.38	104.2	-9.0	217.5	158.0	-34
Core	50	0.24	0.07	107.3	80.6	134.9	164.5	-35
All	55	0.19	0.08	211.9	95.5	328.4	322.5	-34

Table 4: True population estimates for medium (50–57 mm in diameter) oysters by stratum, the background stratum (BK), the Bonamia survey area (Core), and the full stock assessment survey area (All). All numbers corrected to true values using a dredge efficiency of 0.17. Shown are the number of stations (No. stations), mean oyster density (per m^2), coefficient of variation (CV), estimated 2025 population size (2025 popn. in millions, blue shaded), and 95% CI's, estimated 2024 population size (2024 popn., grey shaded), and %change from 2024 to 2025 (orange for decrease, green for increase).

Stratum	No. of stations	Mean density	Density CV	2025 popn.	lower 95%	upper 95%	2024 popn.	% change
B1	3	0.20	0.29	7.4	3.1	11.6	5.4	37
C7a	3	0.30	0.46	10.7	1.1	20.2	6.4	67
C7	3	0.12	0.21	2.8	1.6	4.0	11.9	-76
E2	7	0.39	0.32	16.7	6.2	27.2	17.0	-2
B3	6	0.34	0.19	15.3	9.5	21.1	20.2	-24
C9	2	0.48	0.26	16.3	8.0	24.6	19.3	-16
C1a	3	0.45	0.36	13.9	4.1	23.6	19.6	-29
C5	3	0.18	0.51	6.8	0.0	13.6	10.0	-32
C8	3	1.01	0.31	26.8	10.6	42.9	31.6	-15
C2	3	0.23	0.57	5.1	-0.6	10.8	14.2	-64
E4	4	0.12	0.64	3.2	-0.8	7.3	2.0	60
C5a	5	0.01	0.72	0.2	-0.1	0.5	2.8	-93
C3	5	0.11	0.20	3.4	2.1	4.8	19.1	-82
B6	3	0.75	0.21	22.4	13.2	31.5	28.2	-21
BK	5	0.30	0.49	187.0	7.4	366.5	179.4	4
Core	50	0.34	0.05	150.9	121.6	180.2	207.7	-27
All	55	0.32	0.07	337.9	155.9	517.7	387.1	-13

Table 5: True population estimates for small (10–49 mm in diameter) oysters by stratum, the background stratum (BK), the Bonamia survey area (Core), and the full stock assessment survey area (All). All numbers corrected to true values using a dredge efficiency of 0.17. Shown are the number of stations (No. stations), mean oyster density (per m^2), coefficient of variation (CV), estimated 2025 population size (2025 popn. in millions, blue shaded), and 95% CI's, estimated 2024 population size (2024 popn., grey shaded), and % change from 2024 to 2025 (orange for decrease, green for increase).

Stratum	No. of stations	Mean density	Density CV	2025 popn.	B. lower 95%	B. upper 95%	2024 popn.	% change
B1	3	1.14	0.38	41.0	10.7	71.3	34.7	18
C7a	3	1.11	0.52	39.9	-0.4	80.3	15.4	159
C7	3	0.60	0.47	14.0	1.2	26.9	39.6	-65
E2	7	1.19	0.26	50.7	24.6	76.8	30.6	66
B3	6	0.96	0.14	42.7	30.9	54.5	48.1	-11
C9	2	1.18	0.03	40.3	37.6	43.0	43.8	-08
C1a	3	1.50	0.26	46.7	22.6	70.7	53.1	-12
C5	3	0.57	0.40	21.2	4.7	37.6	32.6	-35
C8	3	1.82	0.13	48.4	35.9	61.0	74.7	-35
C2	3	0.96	0.43	20.8	3.1	38.5	33.5	-38
E4	4	1.47	0.58	40.9	-5.8	87.7	8.6	376
C5a	5	0.23	0.76	5.4	-2.7	13.6	51.5	-90
C3	5	0.82	0.39	26.8	6.2	47.3	58.3	-54
B6	3	3.89	0.06	115.7	101.2	130.2	108.9	6
BK	5	1.11	0.37	681.3	185.6	1177.1	272.1	150
Core	50	1.24	0.04	554.6	466.6	642.5	633.3	-12
All	55	1.16	0.05	1235.9	732.4	1739.4	905.4	37

Table 6: Population estimates and percentage change between years in the Bonamia survey area, for large, medium, and small oysters from the 2012, and 2016–2025 surveys, and for extra-large oysters for the 2019–2025 surveys. % change between sequential survey shows annual increases or decreases in population size. All numbers corrected to true values using a dredge efficiency of 0.17. Shown are mean density per m^2 and associated CV's, estimated population size in millions (Pop.n) and associated 95% confidence intervals, and % change from previous survey (orange for decrease, green for increase).

	Mean density (m^{-2})	CV	Pop.n	B. lower 95% CI	B. upper 95% CI	% change
2012						
Large/extra-large	1.40	0.09	688.1	449.2	1046.7	
Medium	0.6	0.10	297.4	192.6	454.4	
Small	0.92	0.16	451.3	261.5	731.7	
2016						
Large/extra-large	0.78	0.09	385.2	246.9	593.8	-44.0
Medium	0.25	0.03	120.5	186.7	491.8	-59.5
Small	0.52	0.07	256.1	155	407.3	-43.3
2017						
Large/extra-large	0.74	0.11	363.6	233.9	559.1	-5.6
Medium	0.25	0.12	123.1	77.5	191.7	+2.2
Small	0.53	0.10	261.9	168.8	401.6	+2.3
2018						
Large/extra-large	1.0	0.11	494.1	315.0	764.9	+35.9
Medium	0.36	0.11	178.4	113.5	276.5	+44.9
Small	0.82	0.13	401.8	249.2	631.2	+53.4
2019						
Extra-large	0.65	0.13	318.7	198.0	500.1	
Large	1.1	0.13	542.5	337.0	851	+9.8
Medium	0.44	0.15	216.5	129.6	346.1	+21.4
Small	1.21	0.10	595.8	385.4	912.5	+48.3
2020						
Extra-large	0.64	0.12	316.1	198.8	492.5	-0.8
Large	1.08	0.12	529.9	333.2	825.7	-2.3
Medium	0.54	0.11	265.3	169.1	410.7	+22.5
Small	2.14	0.14	1052.4	644.4	1665.9	+76.6
2021						
Extra-large	0.82	0.70	405.6	271.0	606.6	+28.3
Large	1.63	0.60	801.4	536.2	1196.7	+51.2
Medium	0.99	0.80	487.0	320.9	733.6	+83.6
Small	2.22	0.70	1091.2	726.3	1637	+3.7
2022						
Extra-large	0.57	0.09	282.1	184.5	428.3	-30.5

	Mean density (m^{-2})	CV	Pop.n	B. lower 95% CI	B. upper 95% CI	% change
Large	1.13	0.09	557.9	366.6	842.9	-30.4
Medium	0.75	0.09	370.3	241.5	563.8	-24.0
Small	2.27	0.10	1116.6	723.1	1709.9	+2.3
2023						
Extra-large	0.57	0.09	135.4	88.4	206.0	-52.0
Large	1.13	0.09	304.5	199.6	461.2	-45.4
Medium	0.75	0.12	204.5	129.6	317.4	-44.8
Small	2.27	0.12	532.8	337.6	827.2	-52.3
2024						
Extra-large	0.26	0.02	114.0	85.3	143.8	-16.1
Large	0.37	0.02	164.5	127.3	201.7	-46.0
Medium	0.46	0.30	207.7	161.0	254.3	+0.1
Small	1.42	0.70	633.3	501.5	765.1	+18.9
2025						
Extra-large	0.17	0.06	75.9	94.7	114.5	-34
Large	0.24	0.07	107.3	80.6	134.9	-35
Medium	0.34	0.05	150.9	121.6	180.2	-27
Small	1.24	0.04	554.6	466.6	642.5	-12

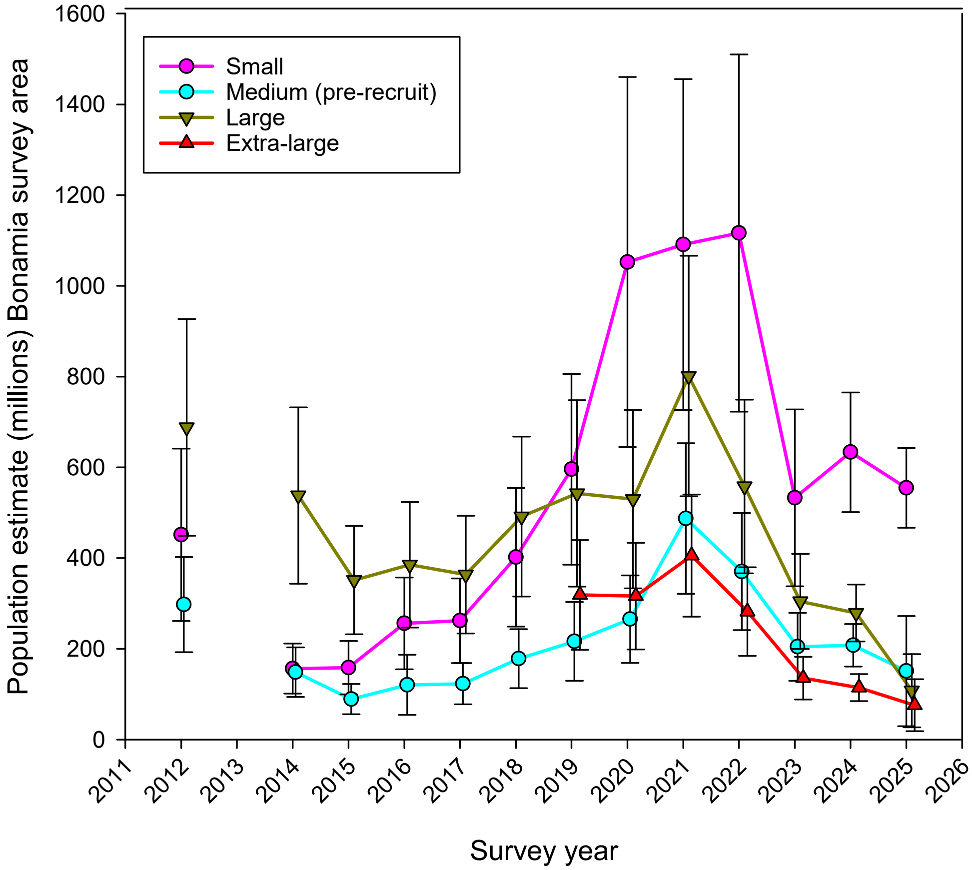

Figure 7: Mean population sizes and 95% confidence intervals for extra-large, large (recruit), medium (pre-recruit), and small oysters in the Bonamia survey area between 2012 and 2025. The survey data for February 2013 are not included (sampling does not cover all the Bonamia survey area). The trends in mean population sizes between 2014 and 2025 are shown as lines.

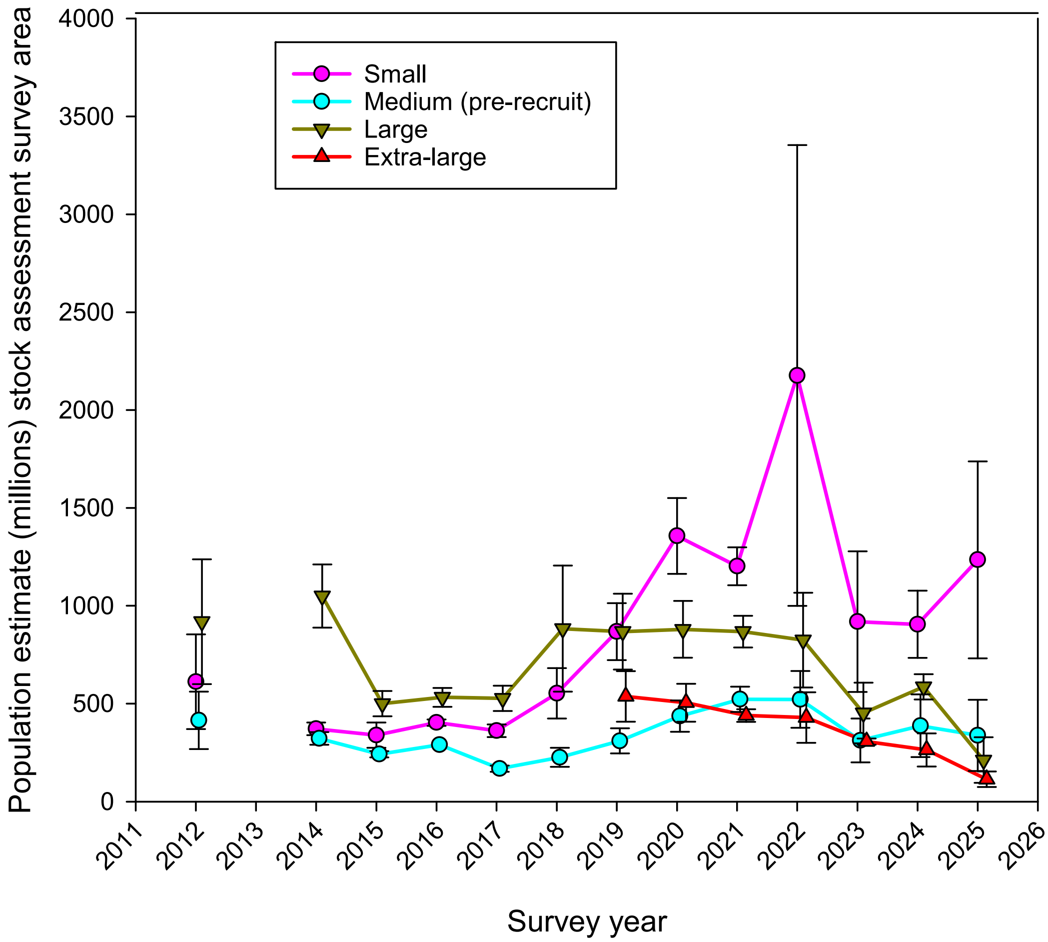

Figure 8: Mean population sizes and 95% confidence intervals for extra-large, large, medium, and small oysters in the 2007 stock assessment survey area between 2012 and 2025. There are no data for the stock area for 2013. Estimates for the stock area from Bonamia surveys should be used with caution because the outer 12 survey strata, combined as stratum BK in Bonamia surveys, were allocated only five survey tows. The trends in mean population sizes between 2014 and 2025 are shown as lines.

Changes in the distribution of live oysters

Data from all 67 stations were used to describe oyster distribution. With only five stations allocated to the large surrounding BK stratum in 2024, little could be inferred for that area from that survey. However, the highest densities of extra-large and large oysters were clustered in the central strata of C1a and C8, along with a single station on the northern side of E2 (Figure 9). In 2025, the spatial distribution of these size classes was similar, with a cluster on the eastern side of C9, extending south-west into northern C8, as well as increasing in extent in C1a (Figures 10, 11). Large oysters were also clustered in this central region in both 2024 and 2025, with smaller patches on the north side of E2, as well as one tow in B6 (Figure 12). Medium oysters were also largely found in this central area, as well as some higher catches in C3 and B6 (Figure 13). Small oysters were present in highest densities in the central area, but high densities were also observed across C3 and B6 (Figure 14).

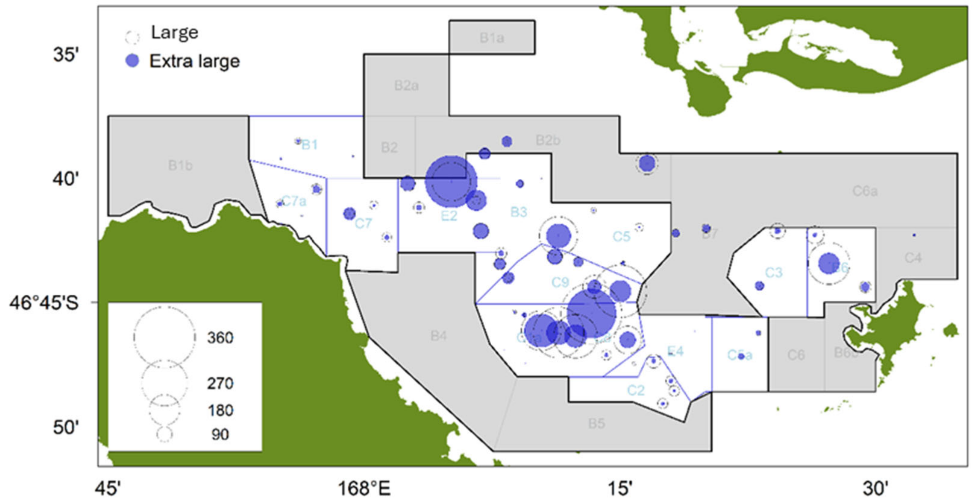

Figure 9: Density of oysters from standardised tows (area swept 1221 m^2) of extra-large (filled blue circles) and large (open black circles) oysters, sampled in February 2024. The Bonamia strata are unshaded, the surrounding single BK stratum is grey shaded.

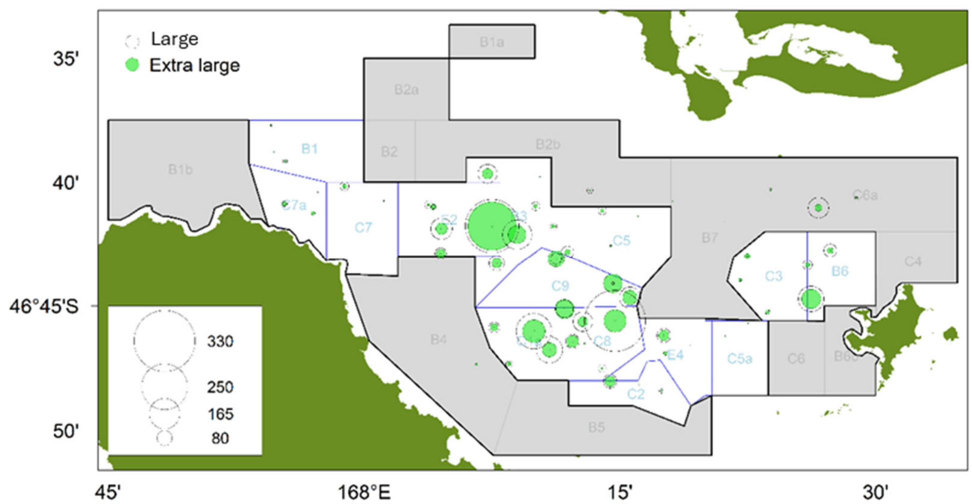

Figure 10: Density of oysters from standardised tows (area swept 1221 m^2) of extra-large (filled green circles) and large (open black circles) oysters sampled during the February 2025 survey. The Bonamia strata are unshaded, the surrounding single BK stratum is grey shaded.

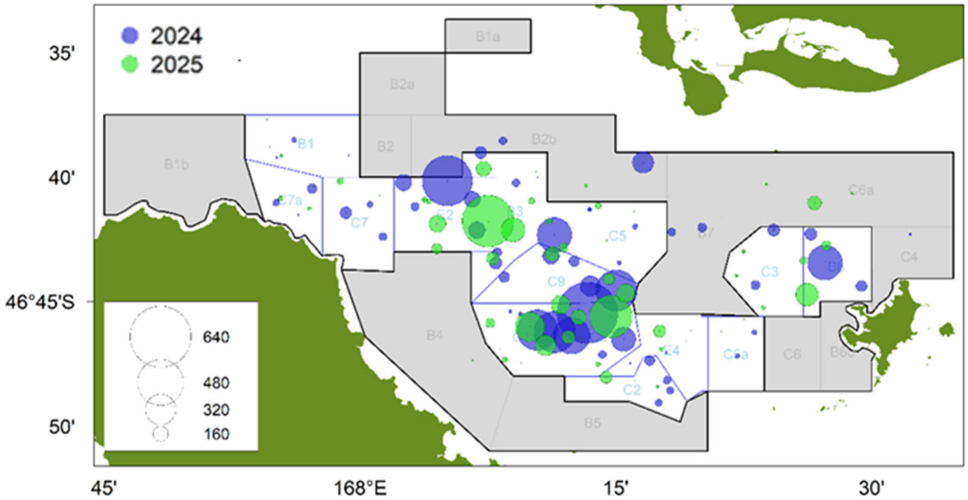

Figure 11: Density of oysters from standardised tows (area swept 1221 m^2) of extra-large oysters sampled during the February surveys in 2025 (filled green circles) and 2024 (filled blue circles). The Bonamia strata are unshaded, the surrounding single BK stratum is grey shaded.

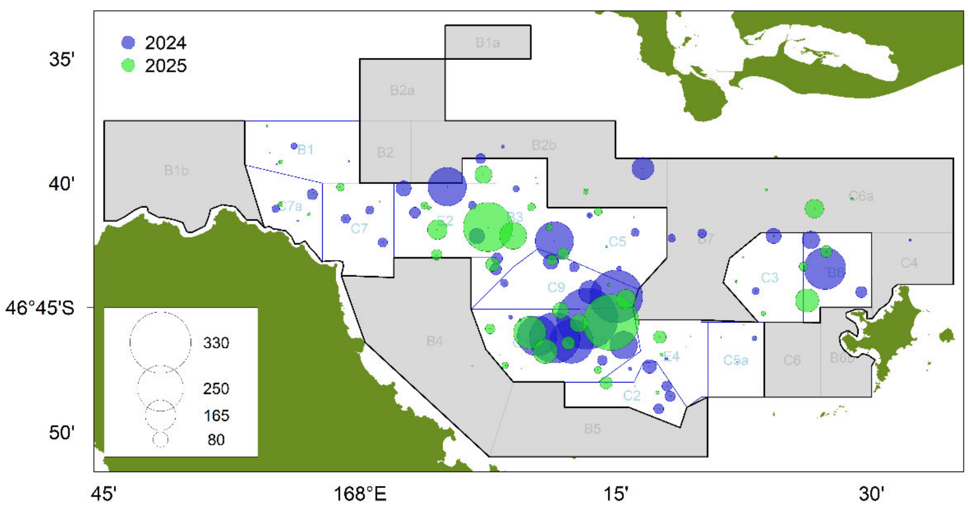

Figure 12: Density of oysters from standardised tows (area swept 1221 m^2) of large oysters sampled during the February surveys in 2025 (filled green circles) and 2024 (filled blue circles)The Bonamia strata are unshaded, the surrounding single BK stratum is grey shaded.

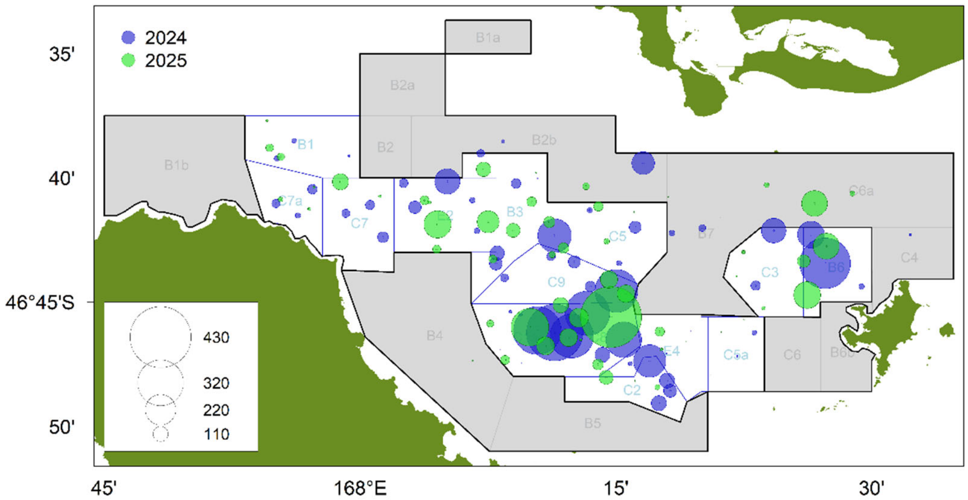

Figure 13: Density of oysters from standardised tows (area swept 1221 m²) of medium oysters sampled during the February surveys in 2024 (filled blue circles) and 2025 (filled green circles). The Bonamia strata are unshaded, the surrounding single BK stratum is grey shaded.

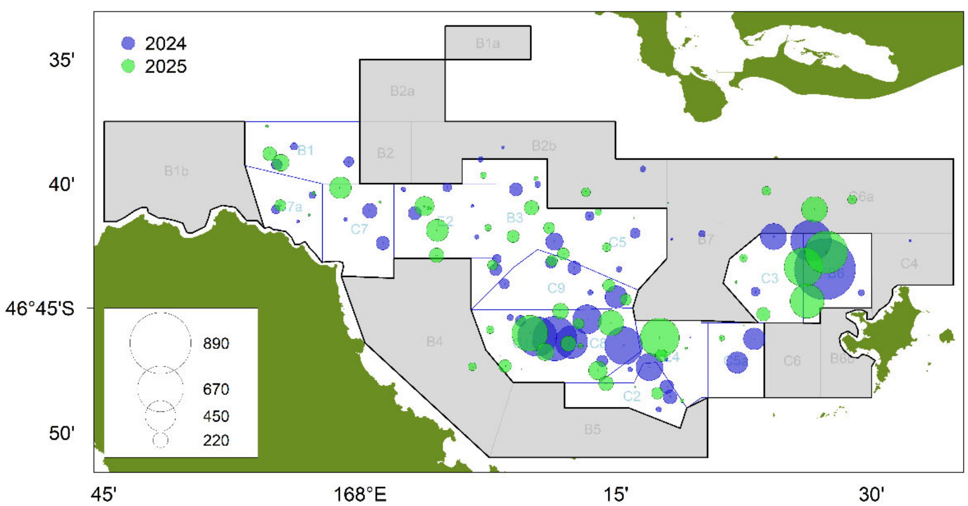

Figure 14: Density of oysters from standardised tows (area swept 1221 m²) of small oysters sampled during the February surveys in 2024 (filled blue circles) and 2025 (filled green circles). The Bonamia strata are unshaded, the surrounding single BK stratum is grey shaded.

Recruitment

Larval oysters settle from the plankton onto settlement surfaces on the seafloor, where they metamorphise into ‘spat’ (a generic term used for shellfish that have recently settled as larvae from the plankton and changed to their ‘benthic form’) (hence the term ‘spat-catchers’ – through strictly speaking they are more larvae competent-to-settle catchers). These oysters remain attached to these settlement surfaces up until around 40 mm, after which they detach to become free-living (there is no biological definition for when Foveaux Strait oysters stop being spat, and start being small oysters, though 10 mm is sometimes used as an arbitrary threshold). Although oyster larvae readily settle on clean shell surfaces, most spat and small oysters are subsequently found on live oysters, possibly because the survival of spat and juveniles is better on large live oysters. Relatively few small oysters are found on other settlement surfaces, except on the saw-shell *Astraea heliotropium*, a ubiquitous and abundant large gastropod. The median numbers of small oysters per recruited oyster is used as a relative index of replenishment to the population, but not an absolute estimate of recruitment.

The ratio of small oysters per large oyster showed large fluctuations in a broadly cyclic trend between 1993 and 2025 (Figure 15). Small oysters per recruit were generally low in number between 1995 and 2001, suggesting reduced recruitment to the population at a time when the numbers of recruit-sized oysters were increasing and relatively high compared with 1993 data (Figure 15). The number of small oysters per recruit was relatively high between 2002 and 2006 when the recruit-sized oyster population was declining rapidly from Bonamia mortality. From 2009, the number of small oysters per recruit declined to low levels and remained low until 2016, whereas the recruit-sized oyster population was increasing. The ratio increased substantially between 2016 and 2020 (Figure 15). It remained similarly high between 2022 and 2025; however, the numbers of recruits increased by 51.2% in 2021 and the numbers of spat per recruit declined slightly, and in 2022 the numbers of recruits decreased by about 30%, resulting in an upward trend in the numbers of small oysters per recruited oyster (Figure 15). In 2023, recruit sized and small oysters both declined by about 50%; however, the median numbers of spat per recruit declined suggesting patchy distributions of small oysters on recruits. The trend in small oysters spat-per-recruit is consistent with the trends in the numbers of small oysters sampled from the commercial catch between 2009 and 2016 (Fu et al. 2013) and the numbers of settlers recorded on spat collectors (Figure 16).

The total numbers of spat per collector sampled over the summers from 2005–06 to 2024–25 is shown in Figure 16. Spat densities were stable from 2019–20 to 2023–24 and then increased by about a factor of five in 2024–25.

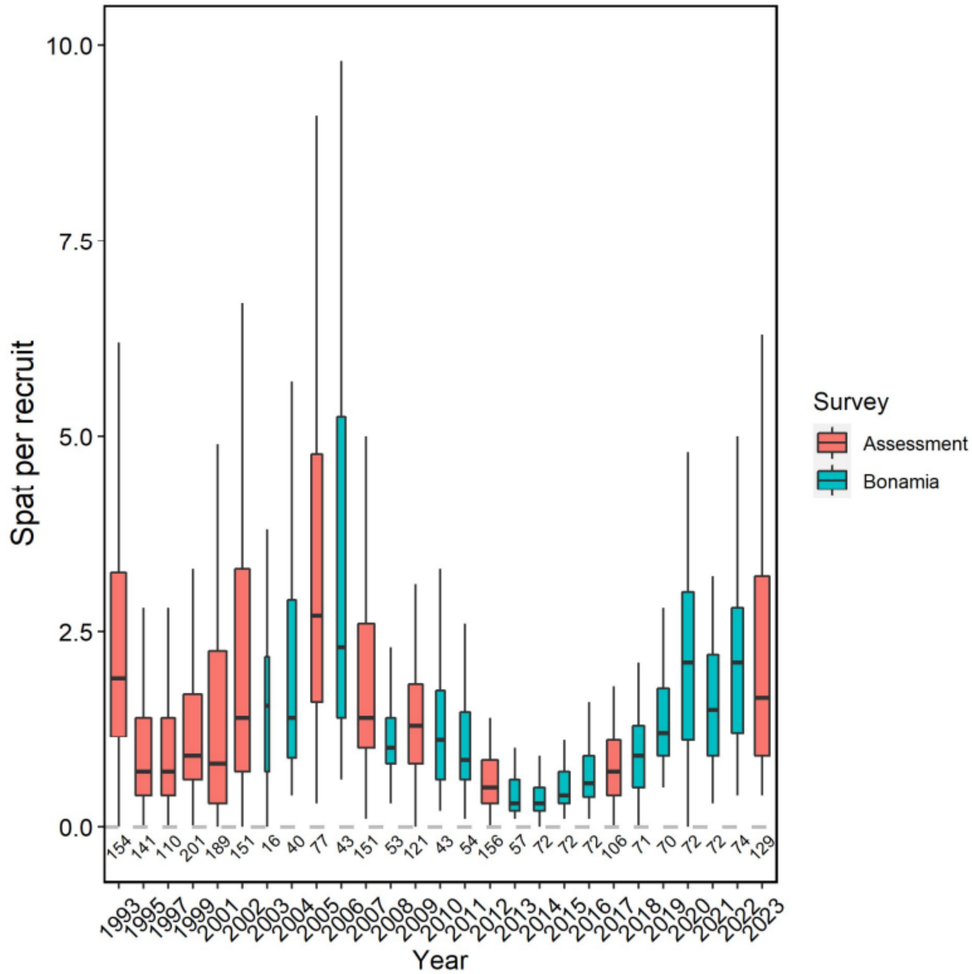

Figure 15: The numbers of small oysters per recruited (large and extra-large) oyster sampled between 1993 and 2023 during the stock assessment and Bonamia surveys. Medians are shown as solid lines, boxes represent 50th percentiles (25–75%), and whiskers 90th percentiles (5–95%). Outliers smaller than 5% and greater than 95% have not been plotted for ease of visualisation. The number of stations sampled each year varied (16 lowest and 201 highest; shown below boxes as black text).

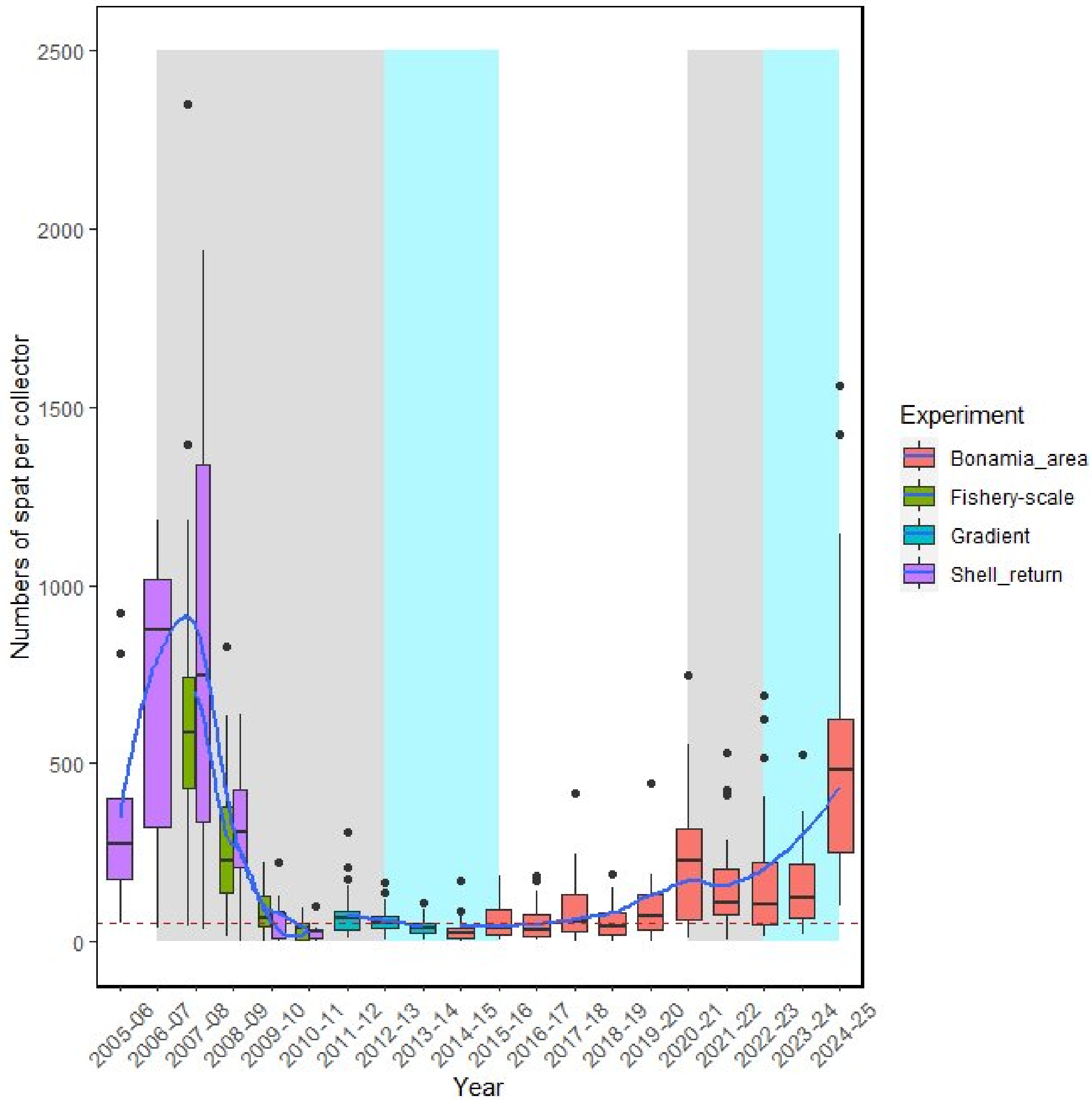

Figure 16: The total numbers of spat per collector sampled over the summers of 2005–06 to 2024–25. Spat settlement shows the success of spawning and indicates the levels of replenishment to the oyster population. Data represent four different experiments and different areas: the shell return site (south of Bluff Hill, in purple), the gradient experiment in the central fishery area (in blue), the fishery-scale experiments (western, southern, and eastern fishery areas in green), and fishery-scale monitoring (Bonamia area annual survey, in salmon) that began over the summer of 2014–15.

3.2 Estimates of mortality before the February 2025 survey

These analyses assume that new clocks remain at the site of death and represent localised mortality. Descriptive statistics for the percentages of recruited (extra-large and large) and medium (pre-recruit) new clocks and gapers combined, sampled from survey stations with more than 50 live recruited-sized and medium (pre-recruit) oysters between 2021 and 2025, are given in Table 7. Widespread mortality was observed in 2025, similar to 2023 and 2024, although the number of new clocks observed in 2025 was lower than in 2024 (Figure 17). Fewer clocks were recorded across both size groups in all strata compared with 2024, except for new large clocks in strata C1a and C2 (Table 8, Table 9). This pattern is most likely driven by the smaller oyster population size in 2025, limiting the opportunities for the development of clocks.

Table 7: The number of stations (No. stations) with more than 50 live recruited (large and extra-large) and pre-recruit (medium) oysters for surveys 2021–2025. The percentage of those stations (Stns (%)) with new clocks and gapers, and descriptive statistics for the percentages of new clocks and gapers for the two size groups.

	Recruited oysters (large and extra-large)					Pre-recruit (medium) oysters				
Year	2021	2022	2023	2024	2025	2021	2022	2023	2024	2025
No. stations	57	64	80	32	33	54	54	60	37	33
Stns (%)	34.0	21.9	82.5	93.7	93.9	13.0	5.0	75.9	86.5	42.4
Average	0.01	0.9	2.0	6.4	3.8	0.0	0.0	0.3	1.7	0.7
Minimum	0	0	0	0	0	0	0	0	0	0
Maximum	0.0	5.7	20.4	18.8	12.3	0.0	2.4	10.0	7.0	3.0

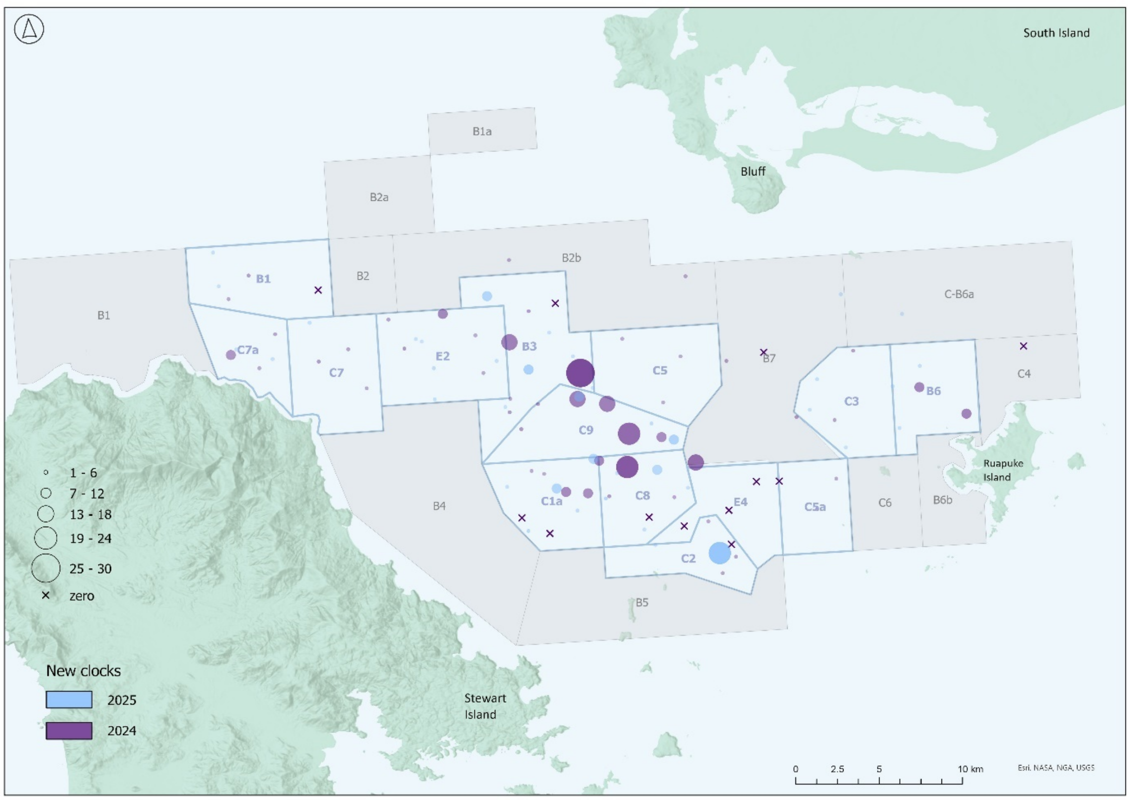

Figure 17: The distribution of recruit-sized new clocks and gaper densities combined in 2024 (filled dark blue circles) and 2025 (filled light blue circles), showing pre-survey mortality observed in February of each year.

Table 8: True population estimates for large (57–65 mm in diameter) new clocks + gapers in each stratum, the background stratum (BK), the Bonamia survey area (Core), and the full stock assessment survey area (All). All numbers corrected using a dredge efficiency of 0.17. Table shows the number of stations (No. stations), mean oyster density (per m^2), coefficient of variation (CV), estimated 2025 population size (2025 popn. in millions, blue shaded), and 95% confidence intervals (B. lower and B. upper), estimated 2024 population size (2024 popn. in millions, grey shaded), and % change from 2024 to 2025 (orange for decrease, green for increase, and white for no change).

Stratum	No. of stations	Mean density (per m^2)	Density CV	2025 popn.	B. lower 95%	B. upper 95%	2024 popn.	% change
B1	3	0.004	0.54	0.15	-0.01	0.31	0.38	-60.3
B3	6	0.2	0.47	0.94	0.08	1.80	1.75	-46.5
B6	3	0.1	0.17	0.25	0.16	0.33	1.29	-80.7
C1a	7	0.02	0.31	0.63	0.24	1.02	0.63	0.2
C2	3	0.04	0.85	0.79	-0.52	2.11	0.23	245.1
C3	3	0.01	0.30	0.32	0.13	0.50	0.63	-49.8
C5	3	NA	NA	0.00	NA	NA	0.2	-100
C5a	3	NA	NA	0.00	NA	NA	0.47	-100
C7	3	0.004	1.00	0.14	-0.13	0.40	0.61	-77.7
C7a	3	0.01	0.61	0.13	-0.03	0.28	0.47	-72.6
C8	5	0.02	0.26	0.51	0.25	0.77	1.12	-54.5
C9	3	0.04	0.26	1.31	0.65	1.98	2.15	-39.0
E2	7	0.01	0.26	0.41	0.20	0.63	0.9	-54.0
E4	4	NA	NA	0.00	NA	NA	0	0
Core	56	0.01	0.07	5.26	5.25	5.27	10.85	-51.5
BK	5	0.005	0.63	3.06	-0.71	6.84	5.35	-42.8
All	61	0.01	0.09	8.32	4.14	12.5	16.19	-48.6

Table 9: True population estimates for medium (50–57 mm in diameter) new clocks + gapers by stratum, the background stratum (BK), the Bonamia survey area (Core), and the full stock assessment survey area (All). All numbers corrected using a dredge efficiency of 0.17. Table shows the number of stations (No. stations), mean oyster density (per m²), coefficient of variation (CV), estimated 2025 population size (2025 popn. in millions, blue shaded), and 95% confidence intervals (B. lower and B. upper), estimated 2024 population size (2024 popn. in millions, grey shaded), and % change from 2024 to 2025 (orange for decrease and white for no change). NA is shown where the 2024 estimate was zero, as percentage change cannot be calculated from zero.

Stratum	No. of stations	Mean density (per m²)	Density CV	2025 popn.	B. lower 95%	B. upper 95%	2024 popn.	% change
B1	3	0.002	1.00	0.06	-0.06	0.17	0.2	-70.6
B3	6	0.005	0.52	0.21	-0.01	0.42	0.27	-22.5
B6	3	0.002	1.00	0.05	-0.05	0.16	0.37	-85.3
C1a	7	0.003	0.65	0.09	-0.03	0.21	0.29	-68.2
C2	3	0.003	1.00	0.07	-0.07	0.21	0.14	-49.3
C3	3	NA	NA	0.00	NA	NA	0.54	-100.0
C5	3	0.002	1.00	0.06	-0.06	0.18	0.2	-69.5
C5a	3	NA	NA	0.00	NA	NA	0.06	-100.0
C7	3	0.006	0.53	0.23	-0.01	0.46	0.12	90.1
C7a	3	0.003	0.51	0.07	0.00	0.14	0.12	-43.0
C8	5	0.005	0.45	0.13	0.02	0.24	0.35	-63.2
C9	3	0.006	0.67	0.22	-0.07	0.51	0.73	-70.0
E2	7	0.001	1.00	0.03	-0.03	0.09	0.29	-89.8
E4	4	NA	NA	0.00	NA	NA	0	0
Core	56	0.003	0.17	1.22	1.21	1.23	3.7	-67.0
BK	5	0.002	0.61	1.2	-0.24	2.66	0	NA
All	61	0.002	0.11	2.4	0.81	3.89	3.7	-34.3

3.3 *Bonamia exitiosa* infection prevalence and intensity

Across 71 stations, *Bonamia exitiosa* was detected in 363 of 1752 oysters (20.7%) using the ddPCR assay. Recruited oysters were targeted for testing at each station, with pre-recruits also tested when fewer larger oysters were observed. Detection of *B. exitiosa* using heart imprints was lower, with 199 oysters testing positive (11.3%) out of 488 imprints examined (363 ddPCR-positive oysters plus 125 randomly selected negatives), assuming the remaining ddPCR-negative samples would also be negative by heart imprint (see Section 2.9). Infection prevalence from ddPCR has continued to increase since at least 2020, however, infection prevalence based on heart imprints declined from 2024 (Figure 18), reflecting the high number of light infections detected by ddPCR (Figure 19). Infection intensities detected by ddPCR are around 50% lower than those observed from 2022–2024 (Table 10). The ddPCR, as a DNA-based method, is inherently more sensitive than visual examination of heart imprints and can detect lighter infections.

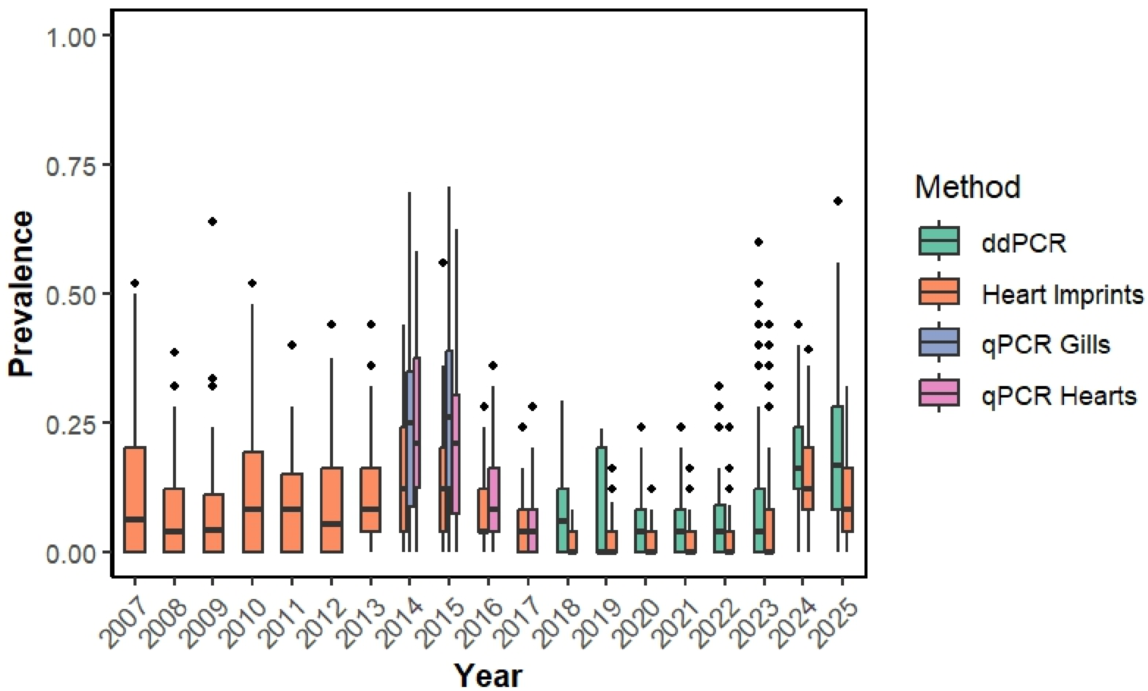

Figure 18: Boxplots of the station-level prevalence of *B. exitiosa*, 2007–2025. Prevalence is calculated for all each station, year and test method used: ddPCR on heart tissue (2018–2025), heart imprints (2007–2025), qPCR of gill tissue (2014–2015), and qPCR of heart tissue (2014–2017). Heart tissue has been tested exclusively with ddPCR since 2018. Medians are shown as solid horizontal lines, boxes represent the 50th percentiles, whiskers indicate the 95th percentiles, and outliers are shown as filled black circles.

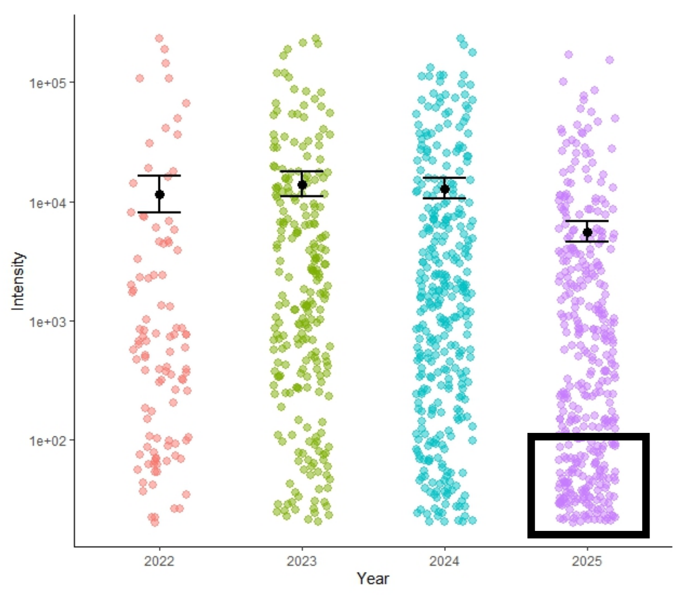

Figure 19: Variation in gene copy numbers (cp/20 µL) for oysters from all stations infected with *Bonamia exitiosa*. Black dots represent predicted means, and error bars indicate 95% confidence intervals based on the negative binomial generalized linear model. The black box indicates the high number of low intensity infections observed in 2025.

Table 10: Negative binomial generalized linear model of ddPCR infection intensity. The intercept represents 2022, and the coefficients represent the effect of each year on infection intensity relative to 2022. Estimates are reported on the log scale.

	Estimate	Std. Error	Z value	P value
Intercept	9.3427	0.1814	51.504	<0.001
2023	0.2026	0.2167	0.935	0.349
2024	0.1115	0.2076	0.537	0.591
2025	-0.7179	0.2054	-3.495	<0.001

3.4 Infection distribution and mortality

In 2025, infection of *B. exitiosa* was widespread across the survey area, with several focal hotspots characterised by high prevalence (Figures 20–24). Multiple stations within strata E2, B3, and C1a had more than 50% of oysters testing positive for *B. exitiosa* via ddPCR (Figure 20, Figure 22); while no stations exceeded 50% positive results using heart imprints. The difference in detection between the two methods was more pronounced in 2025 than in 2024, when 18.1% of oysters tested positive by ddPCR compared with 14.3% by heart imprints, increasing to an almost 10% difference in 2025 (Section 3.2; Figure 17).

The overall distribution of infection in 2025 is generally similar to that in 2024, being widespread with high infection prevalence. Notably, there was a proportional increase in non-fatal infections detected by heart imprints, representing approximately 35% of infections in 2025 compared with 25% in 2024. This trend is further highlighted by the large increase in oysters testing positive by ddPCR, rising to 24.5% in 2025 from 11.5% in 2024. This reflects the higher sensitivity of ddPCR, which detects light infections that are missed by visual examination, indicating recent infections and ongoing parasite transmission. Since infected oysters cannot recover, mortality is expected to continue at stations such as 15 and 69 (strata E2 and C8, respectively), where all infections were non-fatal and oyster abundances are comparatively high.

There is clear evidence of substantial parasite transmission within the OYU 5 fishery, with infection becoming increasingly widespread and common since 2022 (Morrison et al. 2025). Three stations had no detectable infections via ddPCR, and five had no detectable infections via heart imprints; these stations were spatially separated (Figures 20–24). Most infections detected were classified as fatal (65.5%), concentrated in the central area of the fishery. Stations 23, 32, 57, and 66 had 100% fatal infections. *B. exitiosa* is released upon host tissue lysis following oyster death and is expected to disperse passively through the water until it encounters a susceptible host, establishing new infections. Therefore, stations with high numbers of fatal infections are likely to experience increased numbers of non-fatal infections in the future.

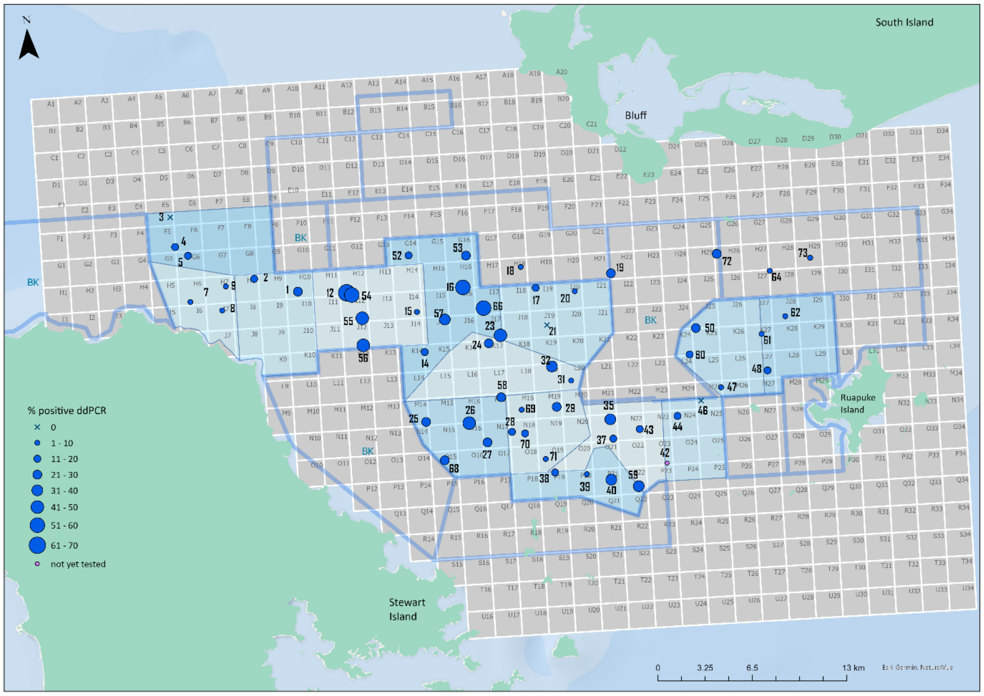

Figure 20: The distribution of *Bonamia exitiosa* infections, as determined by ddPCR in recruit-sized oysters in February 2025. Blue circles indicate the percentage of oysters at each station that tested positive. Stations without infections are shown as blue crosses.

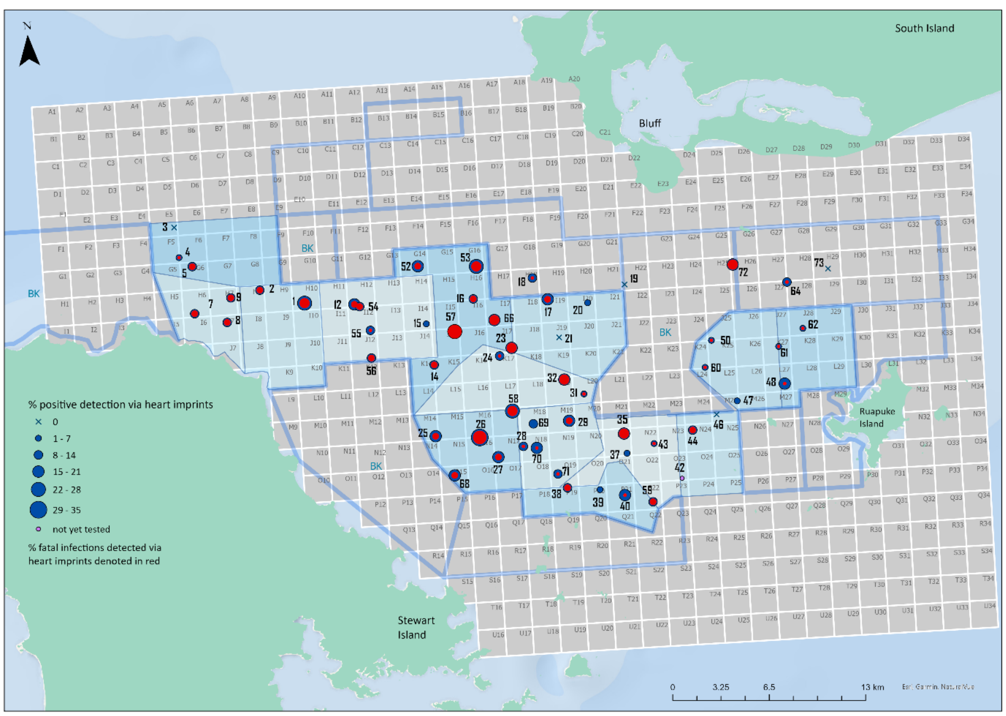

Figure 21: The distribution of *Bonamia exitiosa* infections, as determined by heart imprints in recruit-sized oysters in February 2025. Blue circles indicate the percentage of oysters at each station that tested positive, and the red circle indicates the percentage of oysters with fatal infections (categories 3 and above). Stations without infections are shown as blue crosses.

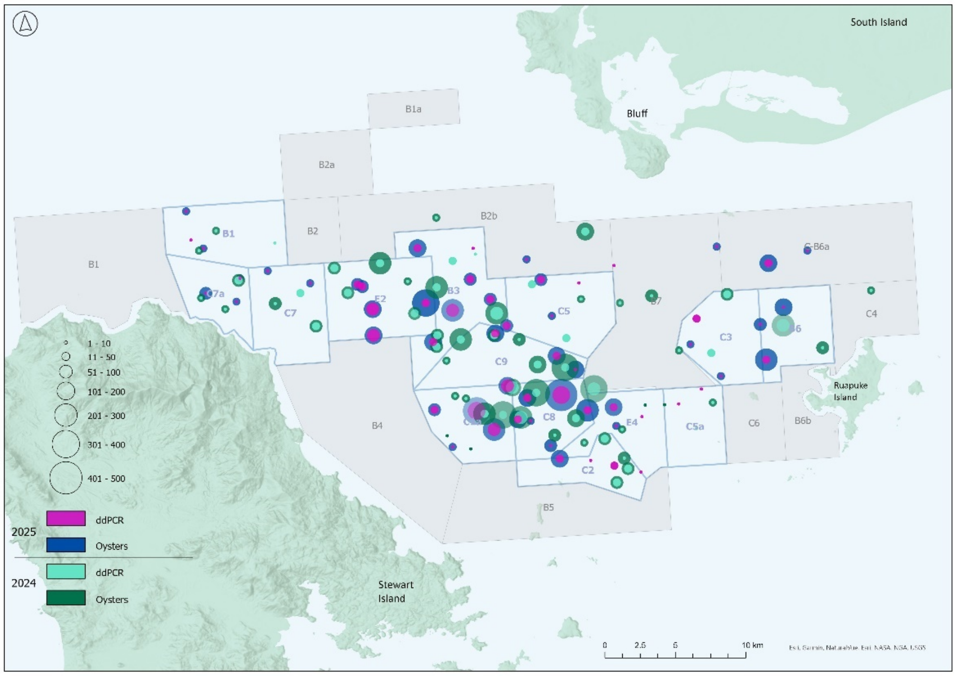

Figure 22: Distribution of infections of *B. exitiosa* in recruit-sized oysters in February 2025, as determined by ddPCR. Dark blue filled circles indicate oyster abundance per standard tow, with pink circles showing the number of oysters testing positive by ddPCR. Values from 2024 are shown for comparison: dark green circles for oyster abundance and light green circles for ddPCR-positive oysters.

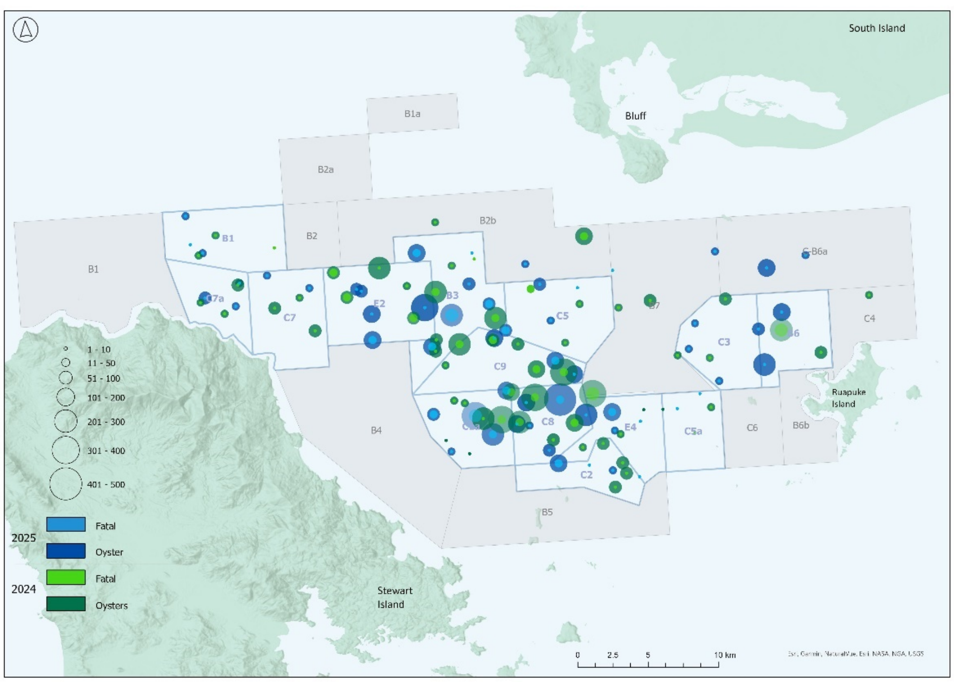

Figure 23: Distribution of fatal infections (categories 3+) of *B. exitiosa* in recruit-sized oysters in February 2025. Dark blue circles indicate oyster abundance per standard tow, and bright blue circles show the number of oysters with fatal infections based on heart imprints. For comparison, 2024 values are shown: dark green circles for oyster abundance and bright green circles for fatal infections.

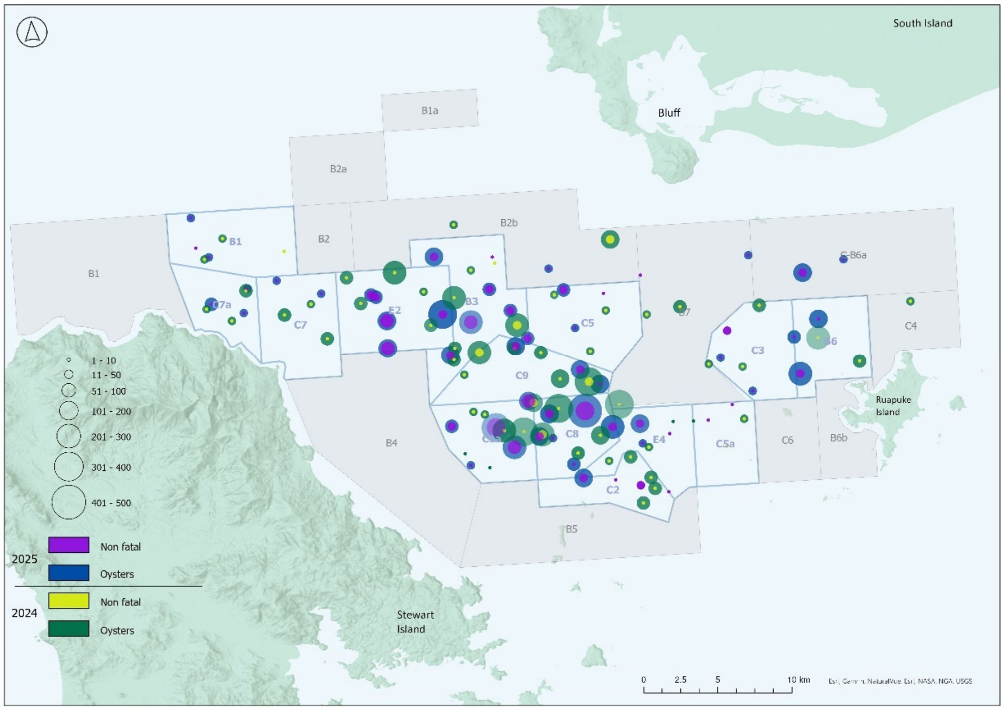

Figure 24: Distribution of non-fatal infections (categories 1 and 2) of *B. exitiosa* in recruited oysters in February 2025. Dark blue circles indicate oyster abundance per standard tow, and purple circles show the number of oysters with non-fatal infections based on heart imprints. For comparison, 2024 values are shown: dark green circles for oyster abundance and yellow circles for non-fatal infections.

3.5 The total number of recruited oysters infected with *B. exitiosa*

Infection prevalence – as determined as the proportion of oysters that test positive for *B. exitiosa* – in core strata (Bonamia survey area), the background stratum, and the stock assessment survey area estimated from heart imprints for 2025 is shown in Table 11, by ddPCR in Table 12, and nonfatal infections (intensity categories 1 and 2) from heart imprints in Table 13.

In 2025, the total number of recruit-sized oysters in core strata infected with *B. exitiosa*, detected by heart imprints, was 27.0 million (95% CI 20.2–33.7, Table 11). This is similar to numbers in previous years: 26.5 million (95% CI 18.1–34.9) in 2024, 20.6 million (95% CI 12.4–32.4) in 2023, and 26.4 million (95% CI 13.7–44.6) in 2022 (Michael et al. 2023a; Michael et al. 2023b). However, due to a declining population size, the proportion of infected oysters in 2025 was 14.7%, higher than 9.5% in 2024, 6.8% in 2023, and 4.8% in 2022.

Increasing numbers and percentages of infected recruited oysters were also seen in the ddPCR results. The number of oysters infected according to ddPCR in 2025 was 45.1 million (95% CI 33.8–56.3), compared with 31.9 million (95% CI 22.6–41.3) in 2024, 33.6 million (95% CI 18.7–55.0) in 2023, and 36.9 million (95% CI 19–62.4) in 2022 (Michael et al. 2023a; Michael et al. 2023b). Similarly, the proportion of oysters infected according to ddPCR was much higher in 2025, with almost a quarter of the core strata population (24.5%) infected, up from 11.4% in 2024, 11% in 2023, and 6% in 2022. A higher number of infected oysters were expected via ddPCR than heart imprints because of the higher test method sensitivity, which detects much lower levels of infection as highlighted by Figure 24 and explained in Section 3.3.

The total number of non-fatal infections in the core strata as determined by heart imprints was 9.4 million oysters (95% CI 7.1–11.8), representing approximately 5% of the recruited population size (Table 12). This is greater than the 6.7 million (CI 95% 3.5–9.9) estimated in 2024, 5.7 million (CI 95% 2.6–10.2) estimated in 2023 and 5.85 million (95% CI 2.68–10.15) in 2022, which corresponds to around 2.4%, 1.9% and 1.0% of the recruited population in 2024, 2023 and 2022, respectively (Morrison et al. 2025, Michael et al. 2023a, Michael et al. 2023b).

Table 11: The 2025 estimates of recruit-sized oysters infected with *B. exitiosa*, estimated by heart imprints, by stratum, scaled to population size in the core strata, background stratum (BK), and for the whole 2007 stock assessment survey area (Survey total). Columns give stratum, and the stratum area (area km^2), number of stations (Stations), estimated number of oysters per square kilometre (oysters/km^2), thousands of oysters, including upper and lower bounds for population size for core and total survey areas, the coefficient of variation of the oyster number estimate (CV), and infected recruit-sized population in millions (Pop.n.), calculated by applying stratum-specific infection prevalence as determined by heart imprints to the total recruited population size, with the percentage of the recruited population shown in parentheses.

Stratum	Area km^2	Stations	oysters/ km^2	Thousands of oysters (l. & u. bounds)	CV	Pop.n.
B1	35.9	3	886.4	31.8	85.4	0.2 (5.9%)
B3	44.3	6	18 624.9	826.0	36.7	4.8 (18.9%)
B6	29.8	3	15 134.5	450.5	80.4	2.7 (13.6%)
C1A	31.0	7	26 270.4	814.9	41.1	4.6 (23.2%)
C2	21.8	3	5 947.0	129.5	62.4	0.6 (11.2%)
C3	32.5	3	1 296.5	42.1	10.2	0.2 (4.0%)
C5	37.4	3	2 973.7	111.2	96.1	0.7 (11.7%)
C5A	23.3	2	183.3	4.3	100.0	0.0 (3%)
C7	35.8	3	3 052.4	109.3	27.4	0.9 (13.7%)
C7A	23.4	3	2 427.9	56.9	29.0	0.3 (7.5%)
C8	26.6	5	24 091.4	641.8	52.1	3.8 (14.8%)
C9	34.2	3	10 408.5	356.0	24.9	2.1 (8.3%)
E2	42.5	7	8 527.6	362.6	25.7	2.7 (9.1%)
E4	27.8	4	5 768.2	160.6	91.8	1.0 (16.3%)
Core total	419.8	55		4 097.5 (2 675.4–5 519.6)	17.4	27.0 (20.2–33.7) (14.7%)
BK	578.3	5	3 240.2	1 995.5	54.9	12.2 (8.6%)
Survey total	1 070.1	60		6 093.1 (3 481.1–8 705.0)	21.4	47.1 (24.5–69.9) (14.4%)

Table 12: The 2025 estimates of recruited oysters infected with *B. exitiosa*, estimated by ddPCR, by stratum, scaled to population size in the core strata, background stratum (BK), and for the whole 2007 stock assessment survey area (Survey total). Columns give stratum, and the stratum area (area km^2), the number of stations sampled (Stations), the estimated number of oysters per square kilometre (oysters/km^2), thousands of oysters, including upper and lower bounds for population size for core and total survey areas, the coefficient of variation of the oyster number estimate (CV), and the infected recruit-sized population in millions (Pop.n.), calculated by applying stratum-specific infection prevalence as determined by ddPCR to the total recruited population size, with the percentage of the recruited population shown in parentheses.

Stratum	Area km^2	Stations	Oysters/ km^2	Thousands of oysters (l. & u. bounds)	CV	Pop.n.
B1	35.9	3	1 552.2	55.8	68.5	0.4 (10.3%)
B3	44.4	6	30 124.1	1335.9	33.6	7.8 (30.6%)
B6	29.8	3	15 991.7	476.0	73.4	2.9 (14.3%)
C1A	31.0	4	34 991.3	1085.4	42.2	6.1 (31.0%)
C2	21.8	4	10 454.1	227.7	58.8	1.1 (19.7%)
C3	32.5	2	4 501.9	146.2	47.4	0.9 (13.9%)
C5	37.4	3	2 973.7	111.2	96.1	0.7 (11.8%)
C5A	23.3	2	274.9	6.4	100.0	0.0 (4.5%)
C7	35.8	3	4 281.9	153.4	31.6	1.2 (19.1%)
C7A	23.4	3	2 305.3	54.0	35.6	0.3 (7.2%)
C8	26.6	4	29 247.2	779.1	51.8	4.6 (18.0%)
C9	34.2	5	24 504.1	838.2	38.6	4.9 (19.6%)
E2	42.5	5	32 311.2	1373.8	22.4	10.3 (34.5%)
E4	27.8	2	11 510.1	320.4	80.5	1.9 (32.5%)
Core total	419.8	49		6 963.5 (4 963.7–8963.4)	14.4	45.1 (33.8–56.3) (24.5%)
BK	578.3	5	3 877.2	2387.8	43.6	14.6 (10.3%)
Survey total	1 070.1	54		9 351.4 (6 463.4–12 239.3)	15.4	78.0 (40.5–115.4) (24.0%)

Table 13: The 2025 estimates of recruited oysters with non-fatal infections (category 1 and 2), estimated by heart imprints, by stratum, scaled to population size in the core strata, background stratum (BK), and for the whole 2007 stock assessment survey area (Survey total). Columns give stratum, and the stratum area (area km^2), the number of stations sampled (Stations), the estimated number of oysters per square kilometre (oysters/km^2), thousands of oysters, including lower and upper bounds for population size for core and total survey areas, the coefficient of variation of the oyster number estimate (CV), and the infected recruit-sized population in millions (Pop.n.), calculated by applying stratum-specific infection prevalence as determined by non-fatal heart imprints to the total recruited population size, with the percentage of the recruited population shown in parentheses.

Stratum	Area km^2	Stations	Oysters/ km^2	Thousands of oysters (l. & u. bounds)	CV	Pop.n.
B1	35.9	3	0.0	0.0	NA	0
B3	44.4	6	1 814.2	80.5	94.9	0.5 (1.8%)
B6	29.8	3	10 522.2	313.2	100.0	1.9 (9.5%)
C1A	31.0	7	6 727.1	208.7	31.2	1.2 (5.9%)
C2	21.8	3	2 769.7	60.3	49.1	0.3 (5.2%)
C3	32.5	3	516.9	16.8	100.0	0.1 (1.6%)
C5	37.4	3	801.6	30.0	85.9	0.2 (3.2%)
C5A	23.3	2	0.0	0.0	NA	0
C7	35.8	3	759.2	27.2	72.7	0.2 (3.4%)
C7A	23.4	3	122.6	2.9	100.0	0.0 (0.4%)
C8	26.6	5	15 663.7	417.3	46.7	2.5 (9.6%)
C9	34.2	3	1 625.8	55.6	100.0	0.3 (1.3%)
E2	42.5	7	4 184.9	177.9	58.2	1.3 (4.5%)
E4	27.8	4	342.2	9.5	100.0	0.1 (1.0%)
Core total	419.8	55		1 399.8 (594.1– 2 205.5)	28.8	9.4 (7.1–11.8) (5.1%)
BK	578.3	5	1 380.1	850.0	65.0	5.2 (3.7%)
Survey total	1 070.1	60		2 249.8 (883.3–3 616.3)	30.4	16.5 (8.6–24.4) (5.1%)

3.6 Projected short-term mortality of recruited oysters from *B. exitiosa*

Projections of post-survey mortality (within about two months of sampling) from the proportion of oysters with fatal (categories three and higher) infections, scaled up to the size of the total recruit-sized oyster population, are given in Tables 14 and 15.

Projected short-term mortality using Method 1 (correction factor) in 2025 reduced the recruit-sized oyster population in core strata by 17.9 million oysters, which is around 9.7%. This estimate would reduce the recruited oyster population from 183.3 million oysters at the time of the survey (February 2025) to 165.4 million by March 2025, i.e., around the time of the new oyster fishing season (Table 16). The estimate of post-survey mortality in core strata from fatally infected oysters scaled to the size of the catch (Method 2) was similar to that estimated by Method 1. Method 2 estimated post-survey mortality of approximately 17.6 million recruited oysters representing 9.6% of that size class in the core strata (Table 16).

Summer mortality was estimated as the percentage of all recruited oyster deaths in the population, from the onset of mortality at the beginning of summer to the end of the seasonal mortality period (around mid-March). Estimated summer mortality in 2025 is higher than in 2022, 2023, and 2024 (Table 16) and is at its highest level since around 2015 (Figure 25). Current estimates for the core strata range between 12.1% and 12.3%, depending on the method used (Table 16). The increasing number of non-fatal infections observed in the 2025 survey suggests that parasite transmission is ongoing and that additional mortality can be expected in the future.

Table 14: Absolute population estimates for recruit-sized oysters after projected mortality from Bonamia based on category 3 and higher infections (correction factor method) by stratum in the core strata, background stratum (BK), and for the stock assessment survey area (Survey total) sampled in February 2025. Columns give the area of each stratum (Area km^2), the number of randomly selected stations sampled (Stations), the recruit population in millions before applying the correction factor (Pop. n^1), the correction factor applied to each stratum (Correction), the recruit population in millions after applying the correction factor (Pop. n^2), the estimated number of oysters expected to die per stratum based on the correction factor (Mortality n), and the percent mortality (Mortality %).

Stratum	Area km^2	Stations	Pop. n^1	Correction	Pop. n^2	Mortality n	Mortality (%)
B1	35.9	3	3.6	0.9578	3.4	0.2	4.2
B3	44.4	6	25.5	0.8305	21.2	4.3	16.9
B6	29.8	3	20.2	0.9600	19.4	0.8	4.0
C1A	31.0	4	19.6	0.8197	16.1	3.5	18.0
C2	21.8	4	5.7	0.9270	5.3	0.4	7.3
C3	32.5	2	6.2	0.9765	6.0	0.1	2.4
C5	37.4	3	5.6	0.9135	5.1	0.5	8.6
C5A	23.3	2	0.5	0.9627	0.5	0.0	3.7
C7	35.8	3	6.5	0.9293	6.0	0.5	7.1
C7A	23.4	3	4.0	0.9200	3.7	0.3	8.0
C8	26.6	4	25.6	0.9487	24.3	1.3	5.1
C9	34.2	5	25.1	0.9301	23.3	1.8	7.0
E2	42.5	5	29.9	0.9498	28.3	1.5	5.0
E4	27.8	2	5.9	0.8490	5.0	0.9	15.1
Core total	419.8	49	183.6	0.9028	165.8	17.9	9.7
BK	578.3	5	142.3	0.9526	135.5	6.8	4.7
Survey total	1 070.1	54	325.9	0.9049	294.9	31.0	9.5

Table 15: Scaled up estimates of the population size of recruited oysters fatally infected with *B. exitiosa*, estimated by heart imprints, by stratum, scaled to population size in the core strata, background stratum (BK), and for the whole 2007 stock assessment survey area (Survey total). Columns give the area of each stratum (Area km²), the number of stations sampled (Stations), the estimated number of oysters per square kilometre (oysters/km²), thousands of oysters, including upper and lower bounds for population size for core and total survey area, and the coefficient of variation of the thousands of oysters estimate (CV), recruited population size in millions (Pop. n).

Stratum	Area km²	Stations	Oysters /km²	Thousands of oysters	CV	Pop. n
B1	35.9	3	886.4	31.8	85.4	0.2 (5.9%)
B3	44.4	6	16810.7	745.5	41.6	4.3 (17.1%)
B6	29.8	3	4612.4	137.3	35.9	0.8 (4.1%)
C1A	31.0	7	19543.3	606.2	48.1	3.3 (17.3%)
C2	21.8	3	3177.3	69.2	84.8	0.3 (6.0%)
C3	32.5	3	779.5	25.3	50.2	0.1 (2.4%)
C5	37.4	3	2172.1	81.2	100.0	0.5 (8.6%)
C5A	23.3	2	183.3	4.3	100.0	0.0 (3.0%)
C7	35.8	3	2293.2	82.1	58.6	0.7 (10.3%)
C7A	23.4	3	2305.3	54.0	35.6	0.3 (7.2%)
C8	26.6	5	8427.6	224.5	63.3	1.3 (5.2%)
C9	34.2	3	8782.7	300.4	36.7	1.8 (7.0%)
E2	42.5	7	4342.7	184.6	32.6	1.4 (4.6%)
E4	27.8	4	5425.9	151.0	99.5	0.9 (15.3%)
Core total	419.5	55		2 697.7 (1 686.5–3 708.8)	18.7	17.6 (13.2–22.0) (9.6%)
BK	578.3	5	1860.1	1145.6	50.8	7.0 (4.9%)
Survey total	1 070.1	60		3 843.3 (2 300.9–5385.6)	20.1	30.5 (15.9–45.2) (9.4%)

Table 16: Summer mortality for 2022–2025 in the stock assessment survey area and in the Bonamia survey area. Summer mortality is estimated as the percentage of recruited oyster deaths from the time mortality began at the beginning of summer to the end of the seasonal mortality (about mid-March), calculated as the percentage of all deaths (pre-survey mortality and post-survey mortality combined) of the recruited population at the beginning of summer (population size of recruited new clocks and population size of recruited oysters at the time of survey combined).

	Stock assessment survey area				Bonamia survey area			
	2022	2023	2024	2025	2022	2023	2024	2025
					Pre-survey mortality			
Recruited new clocks (NC, millions)	10.3	12.3	16.2	8.3	7.4	8.4	10.8	5.3
					Post-survey mortality			
Correction factor (millions of oysters)	21.3	18.9	30.6	31.0	20.7	14.8	18.8	17.9
Scaled catch (millions of oysters)	21.1	29.0	33.9	30.5	20.5	14.9	19.8	17.6
					Combined summer mortality			
Correction factor +NC (millions of oysters)	31.6	31.2	46.8	41.8	28.1	23.2	29.6	23.2
Scaled catch +NC (millions of oysters)	31.4	41.3	50.1	41.3	27.9	23.3	30.6	22.9
					Population before summer mortality			
Recruited oysters + NC (millions of oysters)	834.7	464.5	602.6	336.7	565.3	312.9	289.8	189.0
					Percent summer mortality			
Correction factor +NC (%)	3.8	6.7	7.8	12.4	5.0	7.4	10.2	12.3
Scaled catch +NC (%)	3.8	8.9	8.3	12.3	4.9	7.4	10.6	12.1

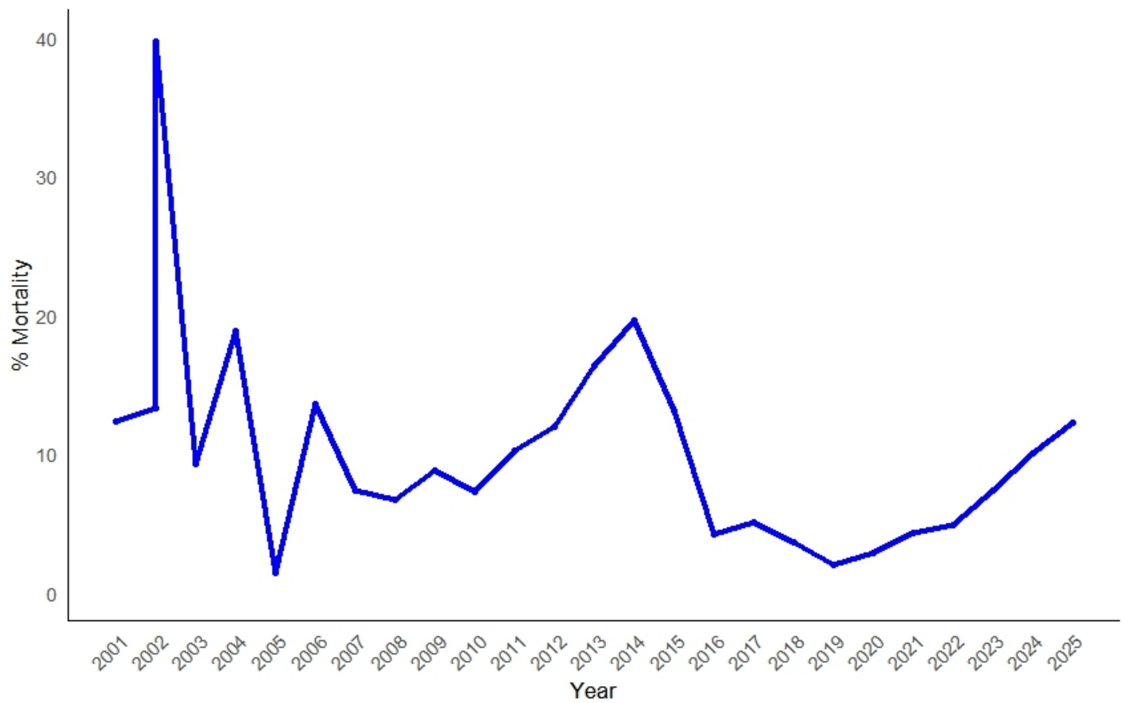

Figure 25: Percentage mortality of the recruited oyster population (including large and extra-large classes) in the Bonamia survey area between 2001 and 2025 (Method 2).

4. DISCUSSION

The current programme of five-yearly stock assessments has placed greater onus on the annual Bonamia surveys to monitor changes in the oyster population in commercial fishery areas, as well as the status of infection of *B. exitiosa*. February Bonamia surveys provide a 'oyster forecast' immediately before the six-month oyster season begins on 1 March. The annual Bonamia survey provides updates on the status of *B. exitiosa* infection and estimates of disease mortality, along with estimates of recruitment from spat monitoring, catch sampling, and survey estimates, which are all important measurements to determine stock trajectory.

4.1 Population estimates

Oyster densities continue to decline in the Bonamia survey area, a decline that started in 2021. The downward trajectory of all four size classes are very similar, although there was a slight increase in the abundance of small sized oysters in 2025.

4.2 Status of infection

Infection prevalence of *Bonamia exitiosa,* as detected by ddPCR, has increased since 2024, reaching the highest levels observed to date. In contrast, prevalence estimated by heart imprints has decreased, with approximately a 9% difference between the two test methods. This pattern is expected and is explained by a high number of light infections detected by ddPCR in 2025, which are likely to be missed by the inherently lower-sensitivity heart-imprint method. These results underscore the importance of ddPCR and the risk of underestimating true prevalence when relying solely on heart imprints. They also highlight the need to link ddPCR infection-intensity data with the non-fatal and fatal infection classifications.

Infections occur across almost the entire survey area, with very few stations showing no detectable *B. exitiosa*. The number of both fatal infections and non-fatal infections has increased throughout the survey area compared with 2024. *B. exitiosa* proliferates within the host, and a fatally infected oyster contains hundreds of thousands of parasites that are released upon host death. The widespread non-fatal infections indicate ongoing parasite transmission. In short, there are currently large numbers of parasites moving through the system driven by ongoing parasite proliferation and host death.

The time required for oysters to progress from non-fatal light infections (scores 1–2 by heart imprint) to fatal infections (3+) and ultimately to host death is important but currently unknown. It is highly likely that stations such as 15 and 69 (strata E2 and C8, respectively), where all observed infections were non-fatal and oyster abundances remain comparatively high, will experience future mortality. The extent of ongoing mortality will be limited only by the number of available hosts. Future mortality is expected, however, as the population continues to decline mortality will eventually slow as transmission becomes less efficient with decreased oyster density.

5. POTENTIAL RESEARCH

The Foveaux Strait fishery is in poor condition at present, with low catch rates and poor meat quality. More explicit spatial management, including the identification of Habitats of Particular Significance to Fisheries Management may be a way forward for better management of the OYU 5 fishery. For the next survey in February 2025, the use of a camera attached to the front of the dredge will be trialled.

6. FULFILMENT OF BROADER OUTCOMES

This project is a long running one, with a well-established field approach. This project is carried out in close collaboration with the Bluff Oyster Management Company (BOMC), with whom we have a longstanding relationship. BOMC provides the vessel and supports this proposal.

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APPENDIX 1 OYSTER CONDITION DETAILS

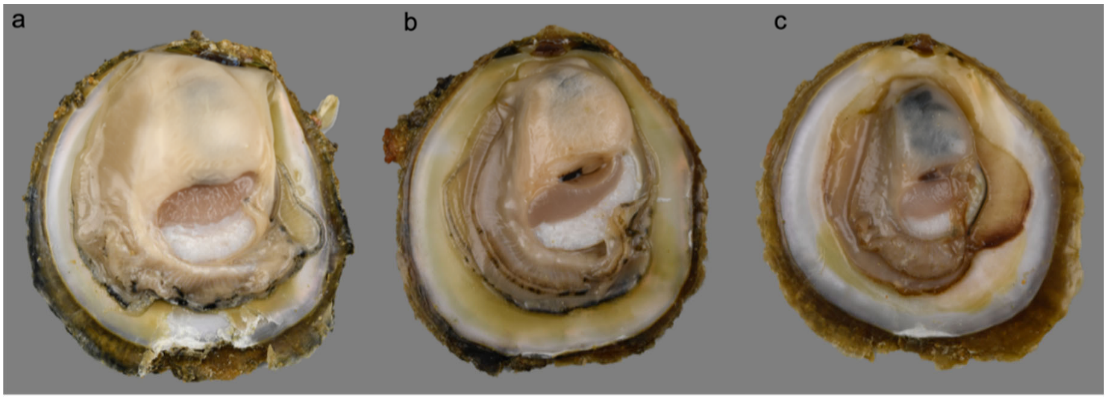

Figure A1.1: Images of oysters with different categories of visual meat quality: a shows good; b shows moderate; and c shows poor quality oysters

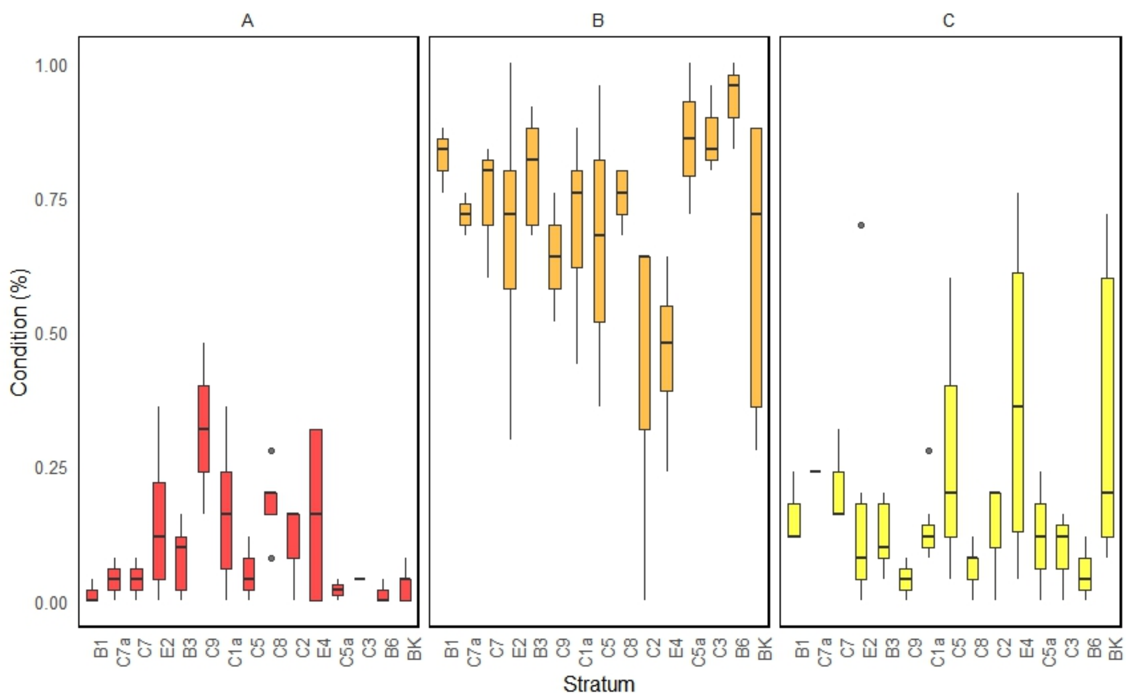

Figure A1.2: Distribution of oyster condition (%) by stratum for conditions A, B, and C. Strata are ordered west-east with BK stratum at the far right. Boxes show the interquartile range (25th–75th percentile), horizontal lines indicate the median, and whiskers extend to 1.5 × the interquartile range.

APPENDIX 2 DIGENEAN TREMATODE DETAILS

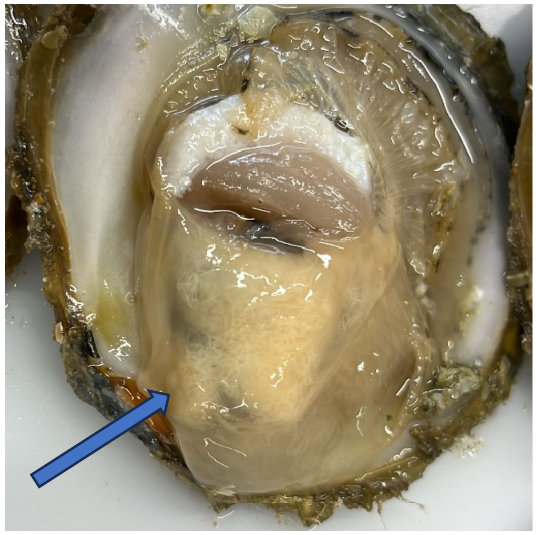

Figure A2.1: Image of an oyster infected with the branching sporocysts of the digenean trematode *Alcicornis (= Bucephalus) longicornutus* (arrow). Note the yellowish webbing appearance within the viscera.

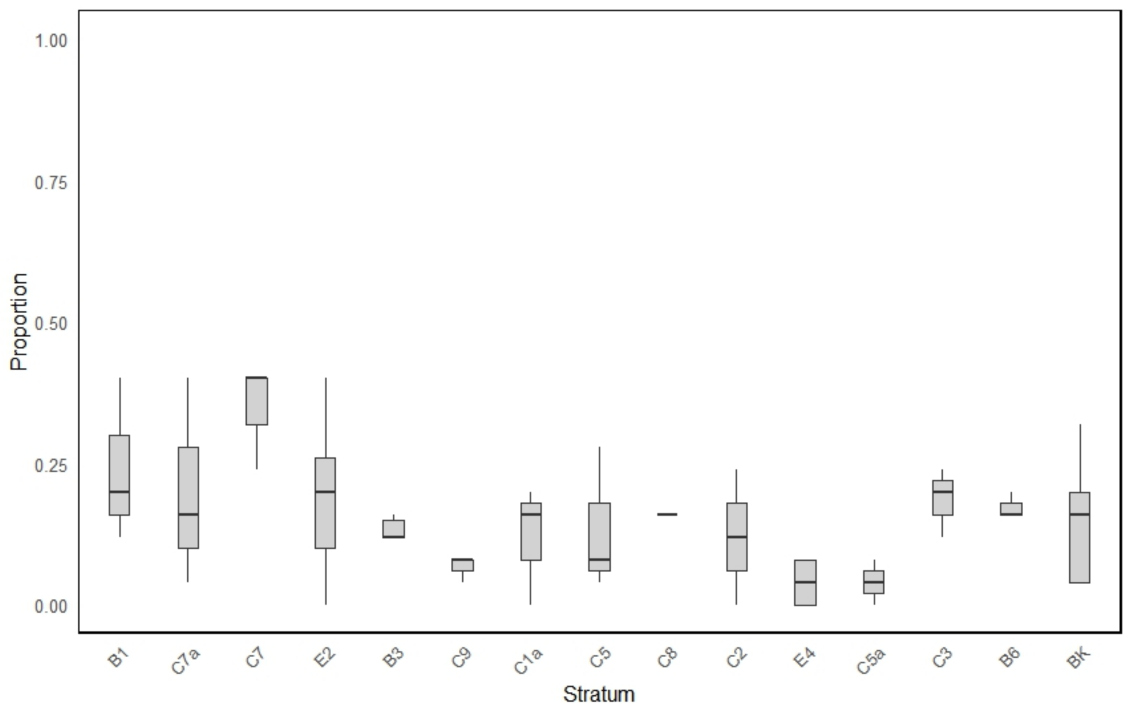

Figure A2.2: Boxplot of proportion of oysters infected with *Alcicornis (= Bucephalus) longicornutus* per stratum. Boxes represent the interquartile range (25th–75th percentile) and the horizontal line inside each box shows the median proportion. Strata are ordered west-east with BK stratum at the far right.

APPENDIX 3 2025 SURVEY INFECTION DETAILS

Table A3.1: *Bonamia exitiosa* infection details by stratum and station of recruited oysters. Non-fatal and fatal imprints and ddPCR *N* are adjusted values scaled to the number of recruit-sized oysters in each catch.

Stratum	Station	Recruited oysters *N*	Oysters tested *N*	Non-fatal heart imprints *N*	Fatal heart imprints *N*	ddPCR *N*	Heart imprints %	ddPCR %
C7	1	17	25	0.68	3.4	4.76	24	28
C7	2	30	25	0	2.4	3.6	8	12
B1	3	22	25	0	0	0	0	0
B1	4	8	25	0	0.32	1.28	4	17
B1	5	25	25	0	2	3	8	12
C7a	7	67	25	0	5.36	5.36	8	8
C7a	8	40	25	0	3.2	3.2	8	8
C7a	9	11	25	0.44	0.88	0.88	12	8
C7	10	35	25	2.8	0	4.2	8	12
E2	12	56	25	4.48	6.72	38.08	20	68
B3	14	132	25	0	15.84	26.4	12	20
E2	15	301	25	12.04	0	24.08	4	8
E2	16	68	25	0	5.44	35.36	8	52
C5	17	67	25	2.68	8.04	10.72	16	17
BK	18	38	25	1.52	1.52	3.04	8	8
BK	19	5	25	0	0	1	0	21
C5	20	7	25	0.28	0	0.28	4	4
C5	21	19	25	0	0	0	0	0
B3	23	98	25	0	19.6	43.12	20	44
C9	24	153	25	6.12	6.12	36.72	8	24
C1a	25	96	25	3.84	11.52	23.04	16	25
C1a	26	325	25	13	91	143	32	44
C1a	27	273	25	21.84	32.76	76.44	20	28
C8	28	147	25	11.76	5.88	23.52	12	16
C8	29	438	25	52.56	35.04	105.12	20	24
C9	31	191	25	0	7.64	7.64	4	4
C9	32	114	25	0	18.24	45.6	16	40
C8	33	203	25	16.24	8.12	32.48	12	16
E4	35	130	25	0	26	46.8	20	36
E4	37	41	25	1.64	0	8.2	4	20
C2	38	163	25	6.52	13.04	32.6	12	20
C2	39	2	25	0.08	0	0.08	4	4
C2	40	30	25	4.8	1.2	12	20	40
E4	43	1	25	0	0.04	0.12	4	14
C5a	44	7	25	0	0.56	0.84	8	14
C5a	46	8	17	0	0	0	0	0
C3	47	49	25	1.96	0	1.96	4	4
B6	48	238	25	38.08	9.52	47.6	20	20
C3	50	37	25	0	1.48	10.36	4	28
E2	51	2	10	0	0	0	0	0

Stratum	**Station**	**Recruited oysters *N***	**Oysters tested *N***	**Non-fatal heart imprints *N***	**Fatal heart imprints *N***	**ddPCR *N***	**Heart imprints %**	**ddPCR %**
B3	52	177	25	14.16	14.16	28.32	16	17
B3	53	7	25	0.56	1.12	1.4	24	25
E2	54	69	25	2.76	5.52	38.64	12	56
E2	55	176	25	7.04	7.04	77.44	8	44
E2	56	129	25	0	15.48	56.76	12	44
B3	57	250	25	0	60	90	24	38
C1a	58	194	25	15.52	31.04	54.32	24	28
E4	59	1	25	0	0.08	0.28	8	30
C3	60	33	25	0	1.32	3.96	4	12
B6	61	69	25	0	2.76	5.52	4	8
B6	62	101	25	0	4.04	4.04	4	4
BK	64	140	25	5.6	5.6	11.2	8	8
B3	66	59	25	0	11.8	30.68	20	52
C1a	67	18	25	3.6	2.16	7.2	32	40
C1a	68	43	25	1.72	5.16	8.6	16	22
C8	69	156	25	12.48	0	12.48	8	8
C1a	70	18	25	2.16	0.72	2.88	16	16
C8	71	52	25	2.08	2.08	4.16	8	9
BK	72	24	25	0.96	3.84	6.72	20	28
BK	73	24	25	0	0	0.96	0	5