

Response to a marine incursion of *Styela clava*

On 14 October 2005, Biosecurity New Zealand initiated a large-scale response to a marine incursion of the fouling organism *Styela clava* (the clubbed tunicate sea squirt). As part of the response, *Styela clava* was declared an unwanted organism under the Biosecurity Act 1993.

Biosecurity New Zealand responded because of the potentially negative impact of the organism on the marine environment and commercial aquaculture⁽¹⁾⁽²⁾. Initial response objectives were to delimit the extent of *Styela clava* infestation and determine whether eradication was feasible.

Styela clava was identified in the Viaduct Harbour, Auckland, on 8 September 2005 and the Port of Lyttelton, Christchurch, on 3 October 2005. Prior to these reports *Styela clava* was not known to be present in New Zealand. The most likely pathway for introduction was adult specimens fouling the hull or internal recesses of international vessels visiting New Zealand⁽³⁾.

Styela clava is a robust organism capable of surviving a wide range of marine environmental conditions. It has an extensive invasive history, having established in many marine locations worldwide outside of its native origins in the coastal waters around North Korea, Japan, northern China and Siberia⁽⁴⁾.

The initial response management was three-tiered. The National Response Centre (NRC), Wellington, was responsible for providing ministerial advice, technical support, public and media communications, and consultation with affected stakeholders. The Incursion and Diagnostic Centre (IDC, Wallaceville) managed operational activities of field teams as directed by the NRC.

Operational activities were carried out by surveillance teams tasked with delimiting the extent of *Styela clava* infestation at the Viaduct Harbour, neighbouring Freemans Bay and the Port of Lyttelton. Other surveillance teams determined whether *Styela clava* was present in key locations around New Zealand's coast, assessed recent and historic reports of *Styela clava*, inspected conveyers such as recreational and commercial vessels, and determined the effect of *Styela clava* infestation on production from affected aquaculture farms. This paper summarises the methods and results from these activities.

Detailed site surveys

Biosecurity New Zealand contracted the National Institute of Water and Atmospheric Research (NIWA) to carry out delimiting surveys of the Viaduct Harbour and Freemans Bay, Auckland, and the Port of Lyttelton, Christchurch, during October 2005. Two survey methods were used to detect the organism: underwater searches using SCUBA, and out-of-water searches from above the water⁽³⁾.

Two hundred and eighty-two specimens were collected, and

The sea squirt *Styela clava* was first identified in New Zealand coastal waters in September 2005. Biosecurity New Zealand's response to the incursion is reported here. *Styela clava* has been declared an unwanted organism under the Biosecurity Act.

confirmed as *Styela clava*, from the two Auckland locations surveyed. Moderate densities were estimated to be one to ten individuals per m² in these locations⁽³⁾. In addition, *Styela clava* was detected in the Westhaven Marina, Auckland. NIWA also reported evidence of infestation in the wider Waitemata Harbour, as boats from outside the Auckland survey locations and the Westhaven Marina were found to be fouled with *Styela clava*. At the Port of Lyttelton a lower level of infestation was observed with only 23 specimens found during the survey of the entire port⁽⁵⁾.

Nationwide surveys

Evidence collected during the Auckland survey and through public reporting suggested that *Styela clava* was widespread through the Hauraki Gulf and that it had been present there for several years. Biosecurity New Zealand considered it likely that the high volume of boat traffic from the Hauraki Gulf had seeded other marine locations with *Styela clava*.

Given the evidence that *Styela clava* may have spread beyond the Hauraki Gulf, further surveys were carried out at 26 other marine locations around New Zealand during November and December 2005 and at five locations during June 2006. *Styela clava* was detected at two of these: Magazine Bay Marina, Lyttelton, and the Tutukaka Marina in Northland. At Tutukaka only two specimens were found.

Criteria used to select the 31 additional survey locations included the amount of boat traffic to the location (as a proxy for risk of infestation), value of commercial aquaculture production in the area, utility and cultural/environmental value assigned to the location, and proximity to known areas of infestation. Included in the survey were 15 ports, 12 marinas and four harbours (Figure 1)⁽⁶⁾.

In conjunction with the surveys, NIWA conducted several experiments to determine the sensitivity of detecting *Styela clava* at different levels of water clarity (Secchi disc reading varying from <1m to >3m). The results were used to calculate the probability of detecting *Styela clava* from out-of-water and in-water surveys at each location⁽⁶⁾⁽⁷⁾. Two unknown factors – the numbers of *Styela clava*, and the proportion of the location perimeter infested – were varied to give probabilities for different infestation scenarios. The purpose of the calculations was to quantify confidence that *Styela clava* was not present where it had not been detected.

There was a low probability of detecting small numbers of *Styela clava* at most survey locations. Given the scenario that one *Styela clava* was present, the out-of-water probability to detect it

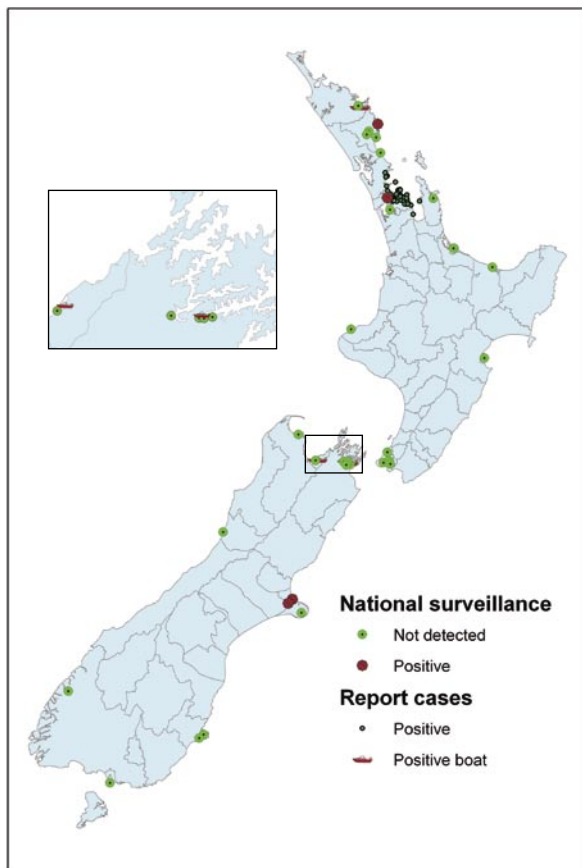


Figure 1: Spatial distribution of nationwide surveillance and report cases confirmed as infested with *Styela clava*. Positive boat report cases do not necessarily imply established populations in the locations where *Styela clava* fouled boats were detected. A detailed map of report cases in the Hauraki Gulf is presented in Figure 4

varied from 2-54% (mean 29%, Std 15%) for the 24 locations where it was not detected. Given the scenario that 200 m of the location perimeter was affected, the in-water probability varied from 8-72% (mean 34%, Std 17%).

Investigation of field reports

Biosecurity New Zealand used targeted press releases to the media, fact sheets, website pages and personalised letters to encourage the general public and marine groups (for example, aquaculture farmers and processors, boating associations and marinas, dive clubs) to report suspected sightings of *Styela clava*.

Informants reporting sightings were asked to describe the specimen to the report case manager. If the report case manager could not rule out *Styela clava*, the person was requested to collect specimens, which were couriered to NIWA (the contracted supplier to Biosecurity New Zealand's Marine Invasive Taxonomic Service), where marine taxonomists identified them. Once it became well established that a wide area within the Hauraki Gulf was infested, generally only specimens from outside this region were requested.

The operations group received two reports of historical infestations from independent researchers. The specimens had been mis-

identified at the time of the research, then reclassified as *Styela clava* on review. These reports confirmed that *Styela clava* was present in the Hauraki Gulf in August 2002 and Lyttelton Harbour in May 2002 (Figure 4). Anecdotal reports from aquaculture personnel from Waiheke Island suggest the organism may have been present in the Hauraki Gulf some years before August 2002.

There were 378 reports of possible *Styela clava* sightings between 30 September 2005 and 30 October 2006 (Figure 2). The majority were from coastal Auckland (61%; 230/378) with 31% (72/230) of Auckland reports coming from Waiheke Island (Figures 3 and 4).

Specimens were requested from 75 reports (20%; 75/378). Of these, 25 were confirmed as *Styela clava*, 32 were negative and 18 informants were not able to collect specimens. Seven of the positive reports were from aquaculture farms. Positive specimens were collected from a variety of habitats including man-made substrata, rocky substrata, boats, mooring ropes, washed up on beaches and attached to shell fragments in soft sediments.

Only three of the 25 positive report case specimens were from marine locations outside the Hauraki Gulf: Northland, Picton and Nelson. Specimens from all of these regions were collected from the hulls of moored boats.

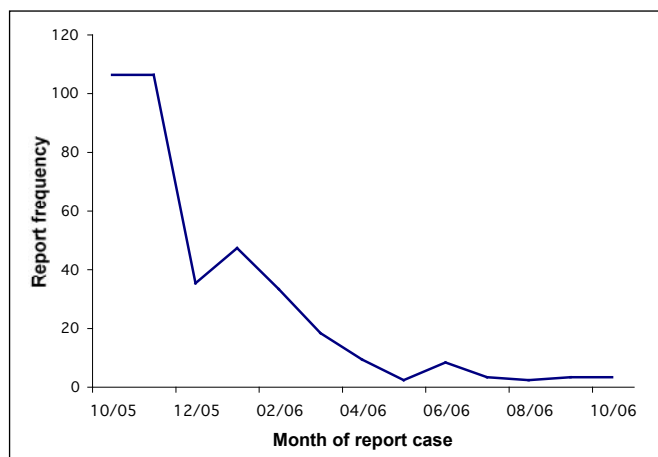


Figure 2: Frequency of reporting suspect finds of *Styela clava* to the Investigation and Diagnostic Centre

The Northland specimens were collected from a boat berthed at Opuia in the Bay of Islands. The boat had returned to New Zealand after sailing overseas. Many of the overseas ports and marinas where the Opuia boat had berthed were known to be infested with *Styela clava*. The boat had not visited any known infested New Zealand locations. A NIWA taxonomist later identified three other fouling crustacean organisms found on the keel of this boat as the first recorded finds in New Zealand (*Hippopodina feegeensis*, *Megabalanus californicus* and *Laticorophium baconi*). These new organisms were considered of low importance based on Biosecurity New Zealand's risk assessment of their likelihood of establishing, and the economic and ecological impact if they were to establish. Despite searches around the site where the boat was moored in

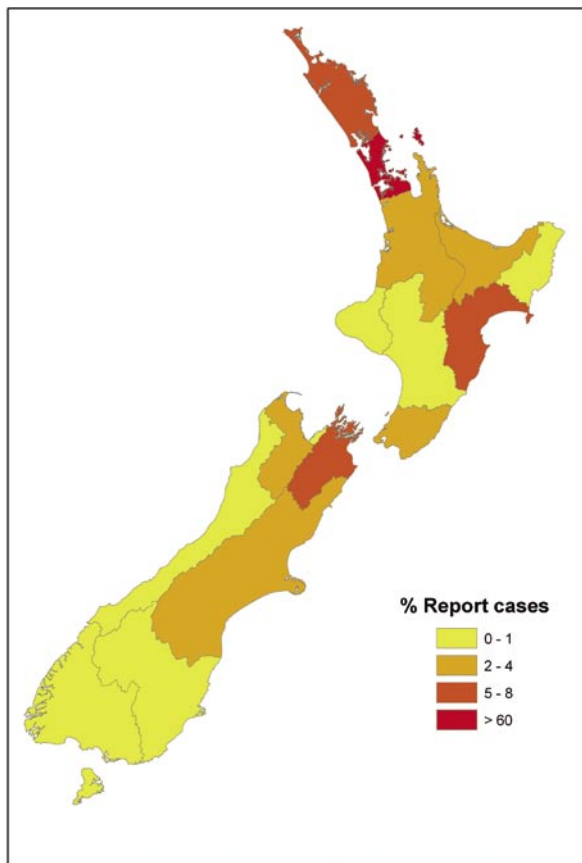


Figure 3: Percentage report cases of suspected *Styela clava* sighted at the coastal part of regional boundaries

Opuia and a repeat survey of the Opuia marina, no *Styela clava* was found. Subsequently, frozen specimens were identified from another boat that had been moored approximately 40 m from the first boat. Investigations are continuing into the relationship between the *Styela clava* finds on these two Opuia boats.

The Nelson specimen was found on a boat that had been moored long-term in Nelson Port. Searches located a single live adult and one dead adult on another boat moored nearby, but no specimens were found on port structures. The second boat had relocated from Auckland Harbour to Nelson Port in the past two years and may have been infested when it arrived. The period for which both Nelson boats had been moored implies that a small population of *Styela clava* may exist in the port region despite the inability of searches to find them⁽⁸⁾.

The Picton report consisted of a single juvenile specimen found on a boat that had recently arrived in Waikawa Marina from the Auckland Viaduct region⁽⁹⁾. No further specimens were found in subsequent searches at the marina.

At-risk boat inspections

Boats or other maritime vessels fouled with reproductively mature *Styela clava* can act as conveyers of the organism to unaffected locations. The operations group received a number of reports from

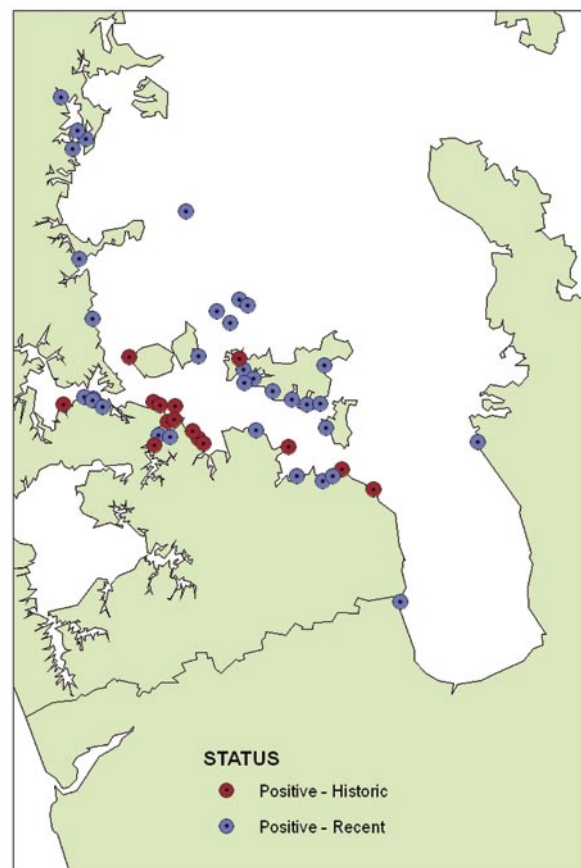


Figure 4: Spatial distribution of sites within the Hauraki Gulf positive for *Styela clava* ('Positive – Historic' refers to *Styela clava* specimens collected and mis-identified at the time of the research but later reclassified as *Styela clava* during the 2005 BNZ response. 'Positive – Recent' refers to *Styela clava* specimens collected and identified during the 2005 Biosecurity New Zealand response)

the public and regional councils of potentially affected boats. Their owners were contacted, and a risk profile based on research carried out by Floerl and others was used to determine the need for the boats to be inspected⁽¹⁰⁾. The risk profile was determined by asking four questions relating to anti-foul treatment and manual cleaning of the boat, frequency of boat usage, and the presence of macro fouling on the boat hull.

Using the risk profile, a surveillance team (Biosecurity New Zealand; AgriQuality New Zealand, Mt Wellington, Auckland; and Kingett Mitchell Ltd, Auckland) assessed 232 boats entered into the 2005 Coastal Classic yacht race and arranged for them to be inspected if required. One hundred and ninety-one owners of vessels were contacted (191/232, 82%); 48 were identified as requiring inspection but 11 boats had already left their moorings and only 37 were able to be inspected. Two of the 37 boats were affected by *Styela clava* (2/37, 5%).

Styela clava was not detected on seven naval vessels at the Nelson Port and four boats in the Marlborough region that had come from the Hauraki Gulf. It was found and removed at the time of inspection from a barge moored at Kawau Island (Hauraki Gulf),

and an ocean-going ship laid up in the Port of Auckland but destined for Northland.

In addition, over the 2005 summer boating season Biosecurity New Zealand marine advisors visited marinas throughout New Zealand to educate the public about marine biosecurity and to encourage regular voluntary cleaning and anti-foul treatment of boats. Inspections of more than 1300 boats took place as part of this public awareness campaign.

Impact assessment of affected aquaculture sites

Seven aquaculture farms (four mussel and three oyster farms), involving multiple leases and sites, were identified from report cases as being affected by *Styela clava*. Low numbers of the organism were reported on six of these farms. The seventh farm was a mussel farm heavily infested with *Styela clava* (Figures 5 and 6). On this farm, an additional labour unit was required to remove large quantities of *Styela clava* from mussel lines during harvest. Despite the high level of *Styela clava* fouling, no effect was observed on mussel growth rate, which remained high.

Biosecurity New Zealand has identified the need for a longitudinal study to quantify the effect of *Styela clava* on the quantities, quality and size of mussels. Data from individual mussel lines from a

heavily infested farm would need to be collected over multiple harvests from the same line, as *Styela clava* infestation would vary with the time of year.

Discussion

This summary of Biosecurity New Zealand's response to the *Styela clava* incursion shows the array of tasks that were necessary to delimit the extent of *Styela clava* infestation and to mitigate risk of spread. Biosecurity New Zealand could not have responded without the public reporting suspect finds and responding to the message of cleaning fouled organisms from boats, or without the assistance provided by many other agencies including NIWA, Kingett Mitchell, Cawthron, regional councils and AgriQuality New Zealand.

High densities of *Styela clava* were found in the Hauraki Gulf. In other locations *Styela clava* was either not detected, or found at very low levels. Given that *Styela clava* had been present in the Hauraki Gulf for a minimum of three years, failure to detect it in many locations outside this area implies that spread via conveyers over large distances may be an unusual event. Most of the spread within the Hauraki Gulf is likely to have come from localised recruitment or spread over short distances on conveyers such as buoys, trees or wood substrata.

The issue of long distance spread may become more important as the *Styela clava* biomass increases in the Hauraki Gulf, resulting in more boats being fouled with the organism. There are few or no controls on fouled boats moving between marine locations. Fouled boats provide a suitable pathway for transfer of *Styela clava* between marine locations, as evidenced by *Styela clava* infested boats in both Northland and Nelson. On one of these boats, recently returned from overseas, there was an incidental finding of three crustaceans not previously recorded in New Zealand. Finding these new organisms demonstrates the ease with which new organisms may enter New Zealand's marine environment. Biosecurity New Zealand is currently undertaking research on boat hull fouling for the purposes of developing border control standards to mitigate the risk of new marine introductions.

Most of the surveillance activities were centred on ports and marinas. However, *Styela clava* was reported in a wide range of marine habitats, including soft sediments attached to buried shell fragments. Extensive habitats such as these require expense and effort to survey. It is also likely that population levels and resulting detection probabilities are low, making it difficult to justify active surveillance in this type of habitat.

Detection probabilities for *Styela clava* were low for most survey locations. A high probability of detecting *Styela clava* implies that the population is well established. In this situation, eradication is almost impossible.

Future marine surveys might benefit from conducting detection probability analysis before selecting survey locations. Minimum probabilities for detecting *Styela clava* could be included in the



Figure 5: A mussel line heavily infested with *Styela clava* (examples of *Styela clava* identified by arrows)



Figure 6: Fouled material, including *Styela clava*, removed from mussel lines during harvest (examples of *Styela clava* identified by arrows)

criteria for selecting survey locations. Alternatively, if surveillance at a specific location is necessary, the marginal increase in detection probability could be determined for each additional unit of surveillance effort. If there were a sufficient increase in detection probability, additional surveillance resources could be allocated to that location.

Evidence for the pathway for transfer of infestation between Auckland and Lyttelton is weak. Hence, the observed populations of *Styela clava* from these two locations may result from multiple incursions. Preliminary genetic analysis of *Styela clava* specimens provides some evidence that they may have come from more than one overseas source⁽¹¹⁾. The most likely source of the Opuia boat infestation is a non-New Zealand location.

This paper highlights the difficulties in responding to a marine incursion. The high cost of response, low detection probabilities, likely organism impact and the lack of barriers to prevent further introductions are factors that need to be considered in any decision to respond to future marine incursions.

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